Measuring mood following Traumatic Brain Injury (TBI) using the Hospital Anxiety and Depression Scale (HADS)

by

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December 2014

Abstract

There is little published research following the emotional recovery of patients with Traumatic Brain Injury (TBI). The present research aimed to investigate in a series of four studies, the relationship between the Hospital Anxiety and Depression Scale (HADS) and a number of variables (demographic, clinical and psychological/physiological) over 2 years following TBI. This large-scale Tasmanian-based population study consisted of 1044 TBI patients (65% males, mean age = 36 yrs) identified from the Neuro Trauma Register database, who completed the HADS and a number of scales and interview questions at the initial follow-up (< 15 days post-injury), 1 month, 3 months, 6 months, 12 months and 24 months post-injury. The data was analysed in a series of longitudinal analyses (repeated measures ANOVAS), cross-sectional analyses (between subjects *t*-tests and ANOVAS), and multiple regression analyses. The findings indicated greater levels of pain and fatigue, lower levels of subjective quality of life (SQOL), and increased severity of post-concussion symptoms were associated with higher levels of anxiety, depression, and psychomotor symptoms across the 2-year post-injury period—with large effect sizes noted. A number of regression models predicted participants' emotional recovery at the later assessments, explaining up to 64% of variance on the HADS. Variables consistently featuring in the models included the HADS Anxiety, Depression, and Psychomotor factors, and variables measuring levels of post-concussion symptoms, SQOL, est. pre-morbid intelligence, and pain. The findings of the present research highlight the importance for early screening of TBI patients' emotional outcome to enable early intervention and suggest the Skilbeck et al. (2011) HADS 3-factor model can be effectively used to identify patients at risk of developing disturbances in anxiety, depression, and psychomotor domains across two years post-TBI. Service implications and directions for future research are discussed.

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Chapter 1

Background to Traumatic Brain Injury

Traumatic brain injury (TBI) refers to transient or permanent neurological dysfunction resulting from an external force to the brain (Helps, Henley, & Harrison, 2008; Khan, Baguley, & Cameron, 2003). A TBI is a type of acquired brain injury. The most common causes of TBI include motor vehicle accidents, assaults, falls, and sporting injuries (Helps et al., 2008). Recreational injuries, electric shocks, and lightening strikes can also cause TBI (HeadInjury, 2012).

The force to the head from a TBI typically results in a concussion, followed by a temporary change in consciousness. The person may be knocked out or lose consciousness. Alternatively, they may remain conscious but appear dazed and disoriented (HeadInjury, 2012). TBI patients commonly suffer post-concussion symptoms such as headaches, blurred vision, nausea, and dizziness (Alexander, 1995). Patients may also suffer neuropsychological deficits, such as memory problems, decreased attention, slower speed of information processing, executive functioning, and communication difficulties (Crowe, 2008).

A TBI is an unexpected and significant event that can lead to profound changes in a person's life (Alexander, 1995). Therefore, patients commonly require rehabilitation following TBI. This involves a number of allied health professionals working with the individual, their family, and carers (Khan et al., 2003). Recovery often needs to occur across a number of different facets of a TBI patient's life, including their physical, behavioural, social, emotional, educational, and occupational functioning (Khan et al., 2003; Novack, 1999).

1.1 Incidence of TBI

TBI is a high-prevalence injury, with thousands of Australians suffering from a TBI every year (Helps et al., 2008). However, as many individuals with mild head injuries do not

present to hospital, the exact number of people with TBI is difficult to measure (Khan et al., 2003). The most recent study published by the Australian Institute of Health and Welfare (AIHW; Helps et al., 2008) examined the incidence of TBI in Australia using the International Classification of Diseases, Version 10, Australian Modification (ICD-10-AM), and found an estimated 22,710 hospitalisations in Australia in the 2004–05 period included a diagnosis of TBI. THE AIHW found the incidence of TBI in the Australian population was approximately 107 per 100,000 per year (Helps et al., 2008).

Mild TBI is the most common type of head injury and has been found to account for between 64 and 131 per 100,000 of the population (Tate, MacDonald, & Lulham, 1998). Moderate and severe TBI are much less frequent (15–20 per 100,000 population and 12–14 per 100,000, respectively; Kraus et al., 1984). There are differences in the age and sex distribution of people with TBI (Helps et al., 2008). TBI is more common in younger people between the ages of 15 and 35 years, occurring in the formative years of their lives (e.g., when they are developing careers or establishing families; Helps et al., 2008; Khan et al., 2003). However, the elderly are also particularly vulnerable to TBI, often due to falls (Khan et al., 2003). The incidence of TBI is also more frequent in males than females (male: female ratio, approximately 2.5:1) and this may result from risk taking behaviour (Helps et al., Khan et al., 2003). The group most at risk of TBI are young males who suffer brain injury from assault or motor vehicle accidents (Helps, 2008).

1.2 TBI Severity

TBI has a broad range of severity and is generally classified as mild, moderate, or severe. It can range from a minor concussion through to permanent vegetative state or death (Khan et al., 2003). Mild and moderate TBI result from a non-penetrating blow to the head or a powerful shaking of the head (HeadInjury, 2012). While many people with these types of injuries suffer little or no consequences, others suffer life-long impairments in functioning

(HeadInjury, 2012). Symptoms of mild and moderate head injury vary greatly and include: cognitive symptoms (e.g., attention, concentration, memory difficulties, and reduced speed of thinking), physical symptoms (e.g., headaches, dizziness, fatigue, sensitivity to noise or bright light, tinnitus, nausea, and blurred or double vision), and behavioural changes (e.g., sleep disturbance and irritability; CDC, 2006).

Severe TBI is caused by blows that crush or penetrate the head. These injuries affect delicate brain tissue and frequently require surgery (HeadInjury, 2012). Patients with severe TBI may experience some of the symptoms associated with mild and moderate TBI. However these symptoms follow a period of unconsciousness and tend to be more severe. Furthermore, severe TBI patients tend to display more extensive cognitive and behavioural problems in areas such as communication, problem solving, insight, impulsivity, and socially inappropriate behaviour (Ponsford, 2002). Patients with severe TBI have longer periods of post-traumatic amnesia (PTA) and/or unconsciousness compared to mild TBI patients and subsequently, longer periods of hospital stay (Beers, 2006). Changes in the brain following severe TBI can lead to medical complications such as increased intracranial pressure (Zasler, 2007), seizures (Silver, McAllister, & Yudofsky, 2005), and neuroendocrine disorders (Zasler, 2007). A patient's movement may be disrupted by spasticity and heterotopic ossification (Zasler, 2007).

1.3 Neuropathology of TBI

Head injury can be classed as open or closed (Beers, 2006). Open head injuries occur when the scalp and scull is penetrated by an object (e.g., sharp objects and bullets). Closed head injuries are the most common type of brain injury and occur without penetration. For example, the head may be struck, violently shaken, or may hit an object. Closed head injuries cause a process of rapid acceleration and deceleration in the brain (Beers, 2006). Acceleration and deceleration can damage brain tissue in a number of areas, shearing and tearing axons

and blood vessels. This can lead to serious medical complications, such as contusions, haemorrhage, and hematomas (Beers, 2006). The types of possible lesions resulting from TBI are enormously varied, resulting in a range of different disabilities across patients (Khan et al., 2003).

Brain injury from TBI can also be classified as primary or secondary (Ponsford, 2002). Primary injury occurs at the time of injury and results directly from the impact to the skull and cranium (Murthy, Bhatia, Sandhu, Prabhakar, & Gogna, 2005). Primary injury can be focal or diffuse. Focal injuries occur in a specific location within the brain and are often caused by falls (Silver et al., 2005). Diffuse injuries are more widespread, tending to follow acceleration/deceleration to white matter from motor vehicle accidents (Silver et al., 2005). Secondary brain injury results from changes to the brain over a period of time following the primary brain injury (Murthy et al., 2005). Hours or days post-injury, the patient with secondary brain injury may experience complications, such as an increase in intracranial pressure, swelling or bleeding within the brain, brain damage, respiratory failure, and hypotension (Ponsford, 2002).

1.4 TBI and Mood

1.4.1 Types of emotional changes.

Although TBI patients commonly suffer post-concussion symptoms and neuropsychological problems they may also experience mood changes (i.e., changes in emotional state; Thayer, 1989) after their injury (Helps et al., 2008). Higher rates of psychological problems have been found in TBI populations compared with the general population (Deb, Lyons, Koutzoukis, Ali, & McCarthy, 1999; Fann et al., 2004). It has been estimated that following TBI, the prevalence of clinically significant psychiatric disturbance is as high as 50% compared with 18% in the general population (Fann et al., 2004). Co-morbidity is high after TBI with many individuals experiencing two or more Diagnostic and Statistical Manual (DSM) axis I disorders (Fleming, Strong, & Ashton, 1998).

However, mood changes do not always cluster together in a form that represents a specific syndrome (Silver, et al., 2005).

It is widely accepted that post-TBI, patients frequently experience mood changes such as depressive, anxiety, and psychomotor symptoms (Nott et al., 2006; Rapoport, McCullagh, Streiner, & Feinstein, 2003). TBI patients have also been found to experience symptoms such as: disinhibition, emotional lability, reduced self-esteem, preoccupation with somatic effects of brain injury, frustration, anger, and withdrawal (Bennett & Raymond, 1997; Crowe, 2008). Some of the common mood changes experienced by TBI patients are discussed in more detail below.

Anxiety. Anxiety is an unpleasant feeling of fear and apprehension, often with qualities of dread, distress, and uneasiness, accompanied by increased physiological arousal (Davison, Kring, & Neale, 2004). The prevalence of anxiety in TBI populations has been reported as high as 70% (Rao & Lyketsos, 2002). Although there appears to be higher rates of anxiety in moderate and severe TBI populations, a number of studies have found a substantial proportion of mild TBI patients (approximately one quarter) also suffer an anxiety disorder (Mooney & Speed, 2001).

Many different types of DSM anxiety disorders have been documented following TBI, the most prevalent being generalised anxiety disorder and post-traumatic stress disorder (PTSD; Moore, Terryberry-Spohr, & Hope, 2006). Common anxiety symptoms following head injury include worry (e.g., about physical injuries and cognitive decline), feelings of fear and uneasiness, and distressing dreams (Rao & Lyketsos, 2002). Patients with TBI suffering anxiety are prone to social withdrawal, tending to feel anxious in social situations, such as being in crowds and around small children (Novack, 1999).

Depression. Depression is distinguished by symptoms of great sadness and apprehension, pessimism, social withdrawal, feelings of worthlessness and guilt, anhedonia

(loss of interest and pleasure in activities), loss of sleep, appetite, and sexual desire (Davison et al., 2004). TBI patients frequently develop major depression following their injury (Jorge et al., 1993). They have also been found to develop other mood disorders such as bipolar affective disorder and cyclothymia (Van Reekum, Bolago, Finlayson, Garner, & Links, 1996).

The frequency of depression following TBI varies in studies from 22 to 50% (Gualtieri & Cox, 1991). TBI patients suffering depression tend to experience apathy or loss of motivation (Fleminger & Oliver, 2003), a decrease in their levels of activity, poor psychosocial functioning, difficulty expressing their skills, and suicidal tendencies (Rapoport et al., 2003). They have also been found to experience greater psychological distress and a higher number of post-concussion symptoms (Rapoport et al., 2003).

Psychomotor. Psychomotor symptoms reflect both excessive mental and motor activity, and slowing in mental and motor activity. These symptoms are known specifically as psychomotor agitation and psychomotor retardation, respectively (Reber & Reber, 2001). Psychomotor changes are observable by others and affect a patient's gross motor activity, motor reaction time, speech, and movement of their limbs, trunk, and head (Sobin & Sackeim, 1997). A patient with psychomotor agitation tends to be unable to sit still. They may pace the room, display handwringing behaviour, or pull/rub their skin or clothing (American Psychiatric Association [APA], 2013). Patients with psychomotor retardation show slowness in their speech, thinking, and movements. They tend to talk less than usual or not at all, and their speech may be quieter, with long pauses before answering questions and lack of inflection (APA, 2013). Although psychomotor symptoms can occur within depressive disorders, they should not be viewed solely as a feature of depression as they can occur within a range of different mental disorders (Silver et al., 2005).

Studies have confirmed that some TBI patients experience psychomotor changes following their injury, although the incidence of these symptoms is unclear in the literature (Holm, 2006; Lippert-Gruner, Kuchta, Hellmich, & Klug, 2006). Patients with TBI experiencing agitation have been found to stay for longer periods of time at rehabilitation facilities, and have lower cognitive and motor abilities, compared with other TBI patients (Nott et al., 2006). Those with TBI and psychomotor retardation tend to feel apathetic. These individuals experience a lack of enjoyment in relation to aspects of their emotional, social, and physical life (Silver et al., 2005).

1.5 Emotional Changes Following TBI: When, Causes and Effects

Emotional changes after TBI can occur acutely or after a delayed onset (Crowe, 2008). Symptoms can strike within 24 hours after a brain injury and tend to spontaneously recover over a few months (Bennett & Raymond, 1997). However, in some individuals, these emotional symptoms continue for an extended period of time.

Emotional changes can be due to organic changes to the brain resulting from head trauma. Injury to the frontal and temporal lobes commonly occurs following brain injury. Frontal lobe damage can produce a number of symptoms of mood disturbance, such as apathy, flat affect, increased emotionality, and feelings of indifference (Damasio & Anderson, 1993). Behavioural changes may also occur, such as impulsivity, aggressive or explosive behaviour, social inappropriateness, and difficulty initiating and completing activities. Temporal lobe damage can produce heightened emotionality, irritability, and flattened affect. Behavioural changes may also occur, such as impulsivity, hypersexuality, and aggressive behaviour (Bennett & Raymond, 1997).

A patient may also develop emotional changes as they adapt to the consequences of an altered life. The term “walking wounded” is commonly used in TBI literature, referring to the vast array of difficulties TBI patients experience, despite the lack of obvious physical damage

(e.g., scars, cuts, and fractures on one's body; Bennett & Raymond, 1997). Physical and cognitive problems post-TBI can lead to difficulty functioning at a pre-injury level across a range of areas, such as communication, mobility, self-care, social, recreational, and occupational functioning (Katz, Ashley, O'Shanick, & Connors, 2006). For example, a person's social functioning may be affected by their forgetfulness, distractibility, slower thinking, and word-finding difficulties.

The changes to a patient's life post-TBI involve a degree of loss as the individual begins to discover they cannot do things as well as they used to. This may result in lowered self-confidence and self-esteem (Bennett & Raymond, 1997; Crowe, 2008). A grief response may follow with reactions such as shock, denial, anger, and depression (Fleminger & Oliver, 2003). For some, the losses after TBI are ongoing and the patient may experience a pervasive sense of grief (Fleminger & Oliver, 2003). Anxiety may occur as a patient feels out of control and insecure about their future (Williams & Evans, 2003). There are other complications that lead to difficulty in psychological adjustment after TBI. For example, factors such as the emotional trauma of the event (e.g., PTSD resulting from a motor vehicle accident), relationship breakdown and changes in family roles, pain due to orthopaedic injuries, sleeping problems, and drug and alcohol use.

It has been suggested that a patient's coping style has an influence on the development of mood problems after TBI (Khan-Bourne & Brown, 2003). Those who coped well with stress pre-morbidly are more likely to have skills that help protect or improve recovery from anxiety and depression post-injury (Khan-Bourne & Brown, 2003). Malia, Powell, and Torode (1995) found that patients with brain injury were more likely to have poorer psychosocial functioning if they used unhelpful coping styles, such as avoidance and wishful thinking.

Emotional problems after TBI can be a hindrance to a patient's overall recovery (Jorge et al., 1993), dramatically altering an individual's personality, cognitions, behaviour, and life satisfaction (Silver, et al., 2005). Therefore, to accelerate recovery and prevent a psychological "snowball" effect, early identification and treatment of emotional symptoms is crucial (Bennett & Raymond, 1997). From as early as possible after brain injury, it is important that patients receive emotional support and education on both the effects of brain injury and techniques to assist in coping with altered post-injury functioning (Bennett & Raymond, 1997). There are a range of treatment options available to treat emotional problems after brain injury, such as pharmacological approaches (Williams & Evans, 2003), cognitive rehabilitation (Katz, et al., 2006), behavioural therapy, and cognitive behavioural therapy (Khan-Bourne & Brown, 2003).

1.6 Assessment of Emotional Problems after TBI

A recent review of clinical practice guidelines for mild TBI by Marshall, Bayley, McCullagh, Velikonja, and Berrigan (2012) recommended that due to the prevalence and effects of mental health issues in mild TBI populations, clinicians should assess mild TBI patients for mental health symptoms and disorders. Standardised structural interviews such as the Structured Clinical Interview for DSM-IV Disorders (SCID) and self-report questionnaires can be useful to assist in screening TBI patients for common mental health issues such as anxiety and depression (Marshall et al., 2012; Soo & Tate, 2012).

Mood problems can be classified using a *categorical* approach (presence/absence of a diagnosed mental disorder), or a *dimensional* approach (which measures the degree to which symptoms are present on a scale/continuum; APA, 2013; Bjelland, Lie, Dahl, Mykletun, Stordal, & Kramer, 2009). Whilst categorical instruments are often utilized, there are marked inconsistencies in the prevalence rates of clinically significant mental disorders in TBI populations and the types of symptoms experienced by patients (Moore et al., 2006). Recent

research suggests that a dimensional framework may be more appropriate when screening for anxiety and depression following TBI (Moore et al., 2006; Strucken, Davis, McCauley, & Clark, 2009), using questionnaires such as the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) and the Hospital Anxiety and Depression Scale (HADS; Zigmond, & Snaith, 1983).

A comprehensive meta-analysis of papers on the emotional symptoms following mild TBI in peer-reviewed journals (Panayiotou, Jackson, & Crowe, 2009) found the most frequently used assessment tools for emotional symptoms after mild TBI were the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and the Symptom Checklist-90-Revised (SCL-90-R; Derogatis, 1994). The meta-analysis also found a number of other assessment tools were used in the papers, such as the Beck Anxiety Inventory (BAI; Beck, 1997), the CES-D (Radloff, 1977), the Hamilton Depression Rating Scale (HAM-D; Hamilton, 1960), and the Impact of Events Scale (IES; Horowitz, Wilner, & Alvarez, 1979).

Although there are many screening and assessment tools that have been administered to TBI participants to measure symptoms of mental illness, not all of these questionnaires appear to have been validated for use in a TBI population. For example, there is a gap in the literature of the suitability of the BAI (Beck, 1997), the HAM-D (Hamilton, 1960), and the IES (Horowitz et al., 1979) with TBI patients. However, there are many scales that have been deemed suitable for administration in TBI populations, including the HADS (Zigmond, & Snaith, 1983), the Neurobehavioral Functioning Inventory (NFI; Kreutzer, Marwitz, Seel, & Serio, 1996), the Patient Health Questionnaire-9 (PHQ-9; Spitzer, Kroenke, & Williams, 1999), the CES-D (Radloff, 1977), the BDI (Beck et al., 1961), the SCL-90-R (Derogatis, 1994), and the Brief Symptom Inventory-18 (BSI-18; Derogatis, 2000; see Bush, Novack, Schneider, & Madan, 2004; Fann et al., 2005; Green, Felmingham, Baguley, Slewa-Younan,

& Simpson, 2001; Hoofien, Barak, Vakil, & Gilboa, 2010; Meachen, Hanks, Millis, & Rapport, 2008; Kennedy et al., 2005; Whelan-Goodinsona, Ponsford, & Schonberger, 2009).

1.7 TBI and Mood Recovery

It can take a long time to recover from a TBI. Overall recovery can continue for 5 years or more following an injury (Khan et al., 2003). Due to the negative impact of mood problems post-TBI, there is a need for an in-depth understanding of how TBI patients' mood recovers over time. However, few studies have investigated this. TBI research tends to focus on physical recovery or on mood disturbance at one particular time point soon after injury (Moore et al., 2006).

From the few available studies, findings suggest that recovering from the emotional problems related to the head injury tends to take some time. Studies have found that at 3 months post-injury a significant proportion of TBI patients experience symptoms of anxiety and depression and are in need of psychological intervention (Roy et al., 2002). At 6 and 12 months post-TBI many patients continue to display mood problems, including psychomotor symptoms (Jorge et al., 2004; Moore et al., 2006). Lippert-Gruner et al. (2006) administered the Neurobehavioural Rating Scale to 41 TBI patients admitted to an intensive care unit. TBI patients displayed a tendency to experience more severe agitation at 12 months post-injury compared with 6 months. TBI patients have also been found to report emotional problems at 2 years post-injury (Ponsford, Olver, & Curran, 1995).

Some studies have found the prevalence of mood disorders remains stable over time following TBI (Bowen, Chamberlain, Tennant, Neumann, & Conner 1999). Bowen et al. (1999) administered the Wimbledon Self-Report Scale (WSRS) to a sample of 77 TBI patients admitted to hospital for at least 72 hrs. The scale was given to the patients at 6 months and 1 year post-injury. The frequency of clinically significant disorders did not change significantly over time. At 6 months post-TBI, 39% of the sample had a clinically

significant mood disorder. A similar number of patients were found to have a mood disorder at 1 year (35%). The same clinical diagnosis was maintained by the majority of the patients (58 patients) at both assessments.

Jorge et al. (1993) assessed 66 TBI patients for the presence of mood disorders during their hospital admission using a structured diagnostic interview. At the initial assessment, 26% of the TBI patients in the sample were diagnosed with major depression. The frequency of major depression remained relatively stable at the 3-month (22%) and 6-month (23%) assessments. At the 12-month assessment, 17% of the TBI patients had major depression. The mean duration of major depression was approximately 5 months.

A study by McCleary et al. (1998) examined the frequency of depression in 105 patients with TBI using the SCL-90-R (Derogatis, 1983) and the Neurobehavioral Rating Scale (NBRS; Levin et al., 1987). The number of TBI patients identified as depressed was similar at 6 months (42%) and 12 months (36%) post-injury. However, a limitation in this study was that due to attrition and the longitudinal nature of the study, a smaller number of patients were assessed at the 12-month assessment.

Long-term studies have found mood disturbance remains for years after TBI and interacts with post-concussion symptoms (Bornestein, Miller, & Van Schoor, 1989). Harrick, Krefting, and Johnston (1994) investigated the perceived problems of 21 persons with severe brain injury at 1 year and 3 years following discharge from a community based rehabilitation program. Loneliness and depression were found to increase over time and were reported most frequently at the 3-year follow-up. However, the results from this study are difficult to generalize due to the small sample size and the restricted selection of only severely brain injured patients. Hoofien, Gilboa, Vakil, and Donovick (2001) explored the outcome of severe TBI patients at an average of 14 years after injury. Patients displayed marked

difficulties in independence and cognitive and vocational functioning. They were also found to have high rates of depression and psychomotor retardation.

However, other research suggests that mood problems decrease in severity over time following TBI. Holm (2006) administered the HADS to 245 patients who had sustained a TBI. In a series of repeated measures MANOVAs, TBI patients were found to display significant recovery in anxiety, depression, and psychomotor symptoms over a 12-month period post-injury. These findings were also confirmed by additional analyses of the data in a study by Holm, Skilbeck, Slatyer, Dean, and Bell (2008).

Hellawell, Taylor, and Pentland (1999) assessed the prevalence of anxiety and depression in 96 patients with moderate and severe TBI. Overall, there was a higher frequency of anxiety than depression across most assessments, measured by the HADS. There was a tendency for patients in both severity groups to display an increase in the prevalence of anxiety and depression at the 12-month assessment and then a decrease in prevalence at the 24-month assessment. The results of this study suggest that emotional problems occur most frequently at 1 year following TBI and by 2 years some patients recover.

Overall, it has been shown that TBI patients can experience mood problems that last for a long time following their injury. However, research in this area is conflicting and the recovery of psychomotor symptoms has been a neglected area of study. The pattern of mood recovery following TBI remains unclear and further research of a longitudinal nature is needed.

Chapter 2

Factors Influencing Mood Post-TBI

A number of factors can contribute to the changes in emotions patients experience after brain injury (Bennett & Raymond, 1997). Some of these factors will be reviewed in this chapter, including: demographic variables (gender, age, pre-morbid intelligence, employment status, socio-economic status, and relationship status), clinical variables (severity, cause of TBI, hospitalisation, and orthopaedic injury), and the psychological/physiological consequences of head injury (pain, fatigue, quality of life, and post-concussion symptoms). Other factors that have been suggested to affect mood following TBI (but are outside the scope of the present research) include: personality and pre-morbid coping styles, history of previous brain injury/illness/learning disability, post-injury medical complications, and family and social support (Bennett & Raymond, 1997; Khan-Bourne & Brown, 2003).

2.1 Demographic Variables

2.1.1 Gender. Many of the studies investigating gender differences post-TBI have tended to focus on physical outcomes. Two major studies found females experienced worse physical outcomes than males post-TBI (Farace & Alves, 2000; Kraus, Peek-Asa, & McArthur, 2000). Farace and Alves (2000) conducted an extensive meta-analysis on 40 studies examining gender differences in TBI patients. Women were found to display worse outcomes than men on variables such as days of PTA and length of hospitalisation (Farace & Alves, 2000). Kraus et al. (2000) measured 795 patients with brain injury on the Glasgow Outcome Scale (GOS) and Glasgow Coma Scale (GCS) over a 3.5-year period. Female patients were more likely to be in a persistent vegetative state or have a more severe disability than males.

Some studies have found no difference between males and females in relation to mood post-TBI (Fann, Katon, Uomoto, & Esselman, 1995; Kaydan et al., 2004). One study found

males displayed signs of significant emotional pathology at 2 years following their injury, although the study used a small sample size (Burton & Volpe, 1988). However, an increasing body of research suggests females experience more symptoms of anxiety and depression compared to males (Glenn et al., 2001; Hibbard, Uysal, Kepler, Bogdany, & Silver, 1998; Sliwinski, Gordon, & Bogdany, 1998).

Bay, Sikorskii, and Saint-Arnault (2009) found in a sample of 159 TBI outpatients, women reported significantly higher levels of depression symptoms and perceived stress, than men. Women were also found to report higher levels of brain injury symptoms, as well as more motor, cognitive, and somatic symptoms on the NFI. Gender differences in depression were found between 1 and 6 months following TBI, but dissipated after 6 months post-injury. It is difficult to generalise the findings from this study as the participants were recruited from rehabilitation settings and represent TBI patients with persistent difficulties.

A study by Glenn et al. (2001) investigating 41 outpatients with mild TBI found female patients reported a greater number of depression symptoms than male patients. However, a limitation in this study was the lack of specificity when analysing the time points post-injury. Participants were included from a range of time periods and their results were analysed together, rather than at separate time points. Therefore, although the mean time since the injury was 41 months, the range and standard deviation were both large.

Balck and Dinkel (2005) found a significant proportion of female TBI patients reported higher levels of anxiety on the BAI compared with male TBI patients, at 6 months post-injury. However, this study utilised a relatively small sample of TBI patients, as it included a mixed sample of participants (TBI and subarachnoid haemorrhage patients, and the spouses of the patients). Furthermore, the results for TBI and stroke patients were pooled, making it difficult to delineate the exact number of patients with TBI and anxiety symptoms. Although little TBI research has examined gender differences in psychomotor symptoms, a recent study

by Skilbeck, Holm, Slatyer, Thomas, and Bell (2011) of 195 TBI patients (severity ranging from very mild to severe), showed females reported significantly higher levels of psychomotor symptoms, as well as anxiety and depression at 2 weeks post-trauma.

As shown, research suggests females tend to experience worse physical outcomes and more mood problems than males after TBI. Gender differences in emotional recovery may be due to women experiencing more severe traumatic responses from TBI. Alternatively, it may occur due to differing ways in which males and females report symptoms. Females may find it easier to admit to having symptoms than males because of greater emotional openness (Farace & Alves, 2000). Studies investigating gender differences in mood post-TBI tend to have small sample sizes, lack specificity in time-points analysed/sample characteristics and do not focus upon psychomotor symptoms. Therefore, future research is needed.

2.1.2 Age. Although research has focused primarily on the relationship between younger adults and TBI, there is evidence older adults suffering from TBI also need rehabilitation (Rapoport & Feinstein, 2001). TBI is highest among young people; however the elderly are also particularly vulnerable to this injury, often due to falls. Epidemiologic studies indicate there is a bimodal incidence of TBI, with young adults and older adults over the age of 70 experiencing higher rates of TBI compared with other age groups (Rothweiler, Temkin, & Dikmen, 1998).

Research has found older patients take longer to physically recover from TBI compared with younger patients, based on GOS and GCS scores (Rothweiler et al., 1998). Older TBI patients do not always completely recover and suffer complications such as sepsis and cardiac arrest (Rothweiler et al., 1998). There is also a higher mortality rate associated with older TBI patients (Rapoport & Feinstein, 2001). Studies have found that older TBI patients show greater absolute neuropsychological impairments (Johnstone, Childers, & Hoerner,

1998) and more psychosocial limitations (Rothweiler et al., 1998) compared with younger patients.

Few studies have examined age differences in mood post-TBI. Little attention has been given to the occurrence of anxiety and psychomotor symptoms in older adults with TBI and the relationship between age and depression is unclear, with many TBI studies excluding older participants (Rapoport et al., 2003). However, it could be expected that older TBI patients would have more mood disturbance than younger patients. It has been postulated that older TBI patients have reduced reserves to tolerate brain injury and consequently suffer from a more destructive injury than younger TBI patients (Rothweiler et al., 1998). Higher rates of mood problems have been found in older patients experiencing more severe TBI compared with younger patients (Jorge, Robinson, Moser, & Tateno, 2004). Older patients may also require more therapeutic interventions and longer periods of stay in rehabilitation facilities (Johnstone et al., 1998).

Although one study found older adults with TBI were at a decreased risk of developing major depression (Rapoport & Feinstein, 2001), some research suggests that major depression is a prevalent TBI complication in older adults (Rapoport, 2003). Glenn et al. (2001) found older patients displayed higher levels of depression on the BDI-II than younger patients, in a sample of 41 TBI outpatients. Skilbeck et al. (2011) found being over 40 years of age was associated with significantly poorer mood and psychomotor functioning at 2 weeks post-TBI.

Rapoport, McCullagh, Shammi, and Feinstein (2005) investigated the relationship between major depression and a number of variables following mild and moderate TBI. Seventy-four TBI patients were divided into two groups based on the presence of major depression. No differences between groups were found in relation to gender, pre-morbid intelligence, employment, education, marital status, duration of PTA, and mechanism of

injury. However, TBI patients with major depression tended to be significantly older (*M* = 41 years) than those without (*M* = 32 years).

Overall, from the small number of studies that have examined the relationship between age and mood post-TBI, the findings have tended to suggest older patients experience poorer mood outcome. However, most of these studies tend to focus on age differences in depression at one particular time point, and therefore little is known about the recovery of older TBI patients in other emotional domains.

2.1.3 Pre-morbid intelligence. Literature suggests that patients' reading abilities are less sensitive to the effects resulting from TBI (Johnstone, Hexum, & Ashkanazi, 1995). Therefore, to estimate pre-morbid intelligence in TBI populations, patients are often administered reading tests such as the National Adult Reading Test (NART). Individuals with lower pre-morbid intelligence have been found to report greater deficits from TBI (Millar, Nicoll, & Thornhill, 2003; Wood & Rutterford, 2006). These studies tend to focus on deficits many years after patients have sustained TBI, such as 16–18 years post-injury.

It could be expected that TBI patients with lower levels of pre-morbid intelligence would experience greater mood problems after TBI, due to potential problems such as less financial security following injury and the compounding effects of brain injury related cognitive difficulties. However there appears to be very little research in this area. A study by Skell et al. (2000) exploring the neuropsychological predictors of distress in a sample of 66 TBI patients found the best predictor of distress level post-TBI was patients' estimated level of pre-morbid intelligence. Anson and Ponsford (2006) found that between 1.5 months and 7 years post-TBI, patients with lower scores on the Wide Range Achievement Test-reading scale (an estimate of pre-morbid intelligence; Wilkinson, 1993) used more ineffective coping strategies.

The literature suggests pre-morbid intelligence tends to relate to patients' education, employment status, and socio-economic status (SES; Groth-Marnat, 2009). These factors can have a detrimental impact upon health, literacy, and access to health and social resources, and consequently, may influence a patient's emotional adjustment post-TBI. Due to the lack of studies examining the effect of TBI patients' pre-morbid intelligence on mood, more research is needed in this area.

2.1.4 Relationship status. It could be expected that after TBI, patients in a significant relationship have less mood problems than single patients. Single TBI patients are without the close emotional support that may be beneficial in coping after their injury (Bennett & Raymond, 1997). For example, an empathic and understanding partner may relieve the patient of their worries and unhelpful thoughts related to the injury. A partner may also play a semi-carer role, supporting the patient with their physical and cognitive losses.

Rather than investigating the relationship between marital status and mood post-TBI, studies tend to focus on change in marital status, using marital status as an outcome measure. Some studies have found no differences in mood based on TBI patients' marital status (Rapoport et al., 2005; Seel et al., 2003). However, a study by Ponsford et al. (2000) found that in a sample of 84 TBI patients, non-distressed patients and highly distressed patients significantly differed in marital status, with unmarried TBI patients more likely to be in the distressed group. Other studies have found unmarried TBI patients report lower life satisfaction than those who are married. For instance, a study consisting of 57 individuals with TBI, found marital status was a significant predictor of life satisfaction at 1 year post-injury, and in combination with functional outcome, explained 25% of the variance in life satisfaction (Hicken, Putzke, Novack, Sherer, & Richards, 2002). Whiteneck, Gerhart, and Cusick (2004) found TBI patients who reported greater environmental barriers were less

satisfied with their life, with the most barriers overall reported by married patients, older patients, and unemployed patients.

There are very few TBI studies examining the association between intimate relationships and mood, and further research is needed in this area.

2.1.5 Employment and SES. TBI results in high rates of unemployment, with studies suggesting unemployment rates range from 34–75% at 2 to 15 years post-injury (Sander, Angelle, Kreutzer, Fernandez, & Carmen, 1997). Research has tended to find that unemployed TBI patients have poorer mood outcome following head injury compared with employed TBI patients. In a study by Bowen, Neumann, Conners, Tennant, and Chamberlain (1998) of 99 TBI patients, TBI patients who were unemployed pre-injury were more likely to report mood disturbances at 6 months post-TBI, with 60% of TBI patients who were unemployed pre-injury reporting disturbances in their mood.

Patients unemployed post brain injury have been found to report lower life satisfaction (O'Neill, Hibbard, Brown, & Jaffe, 1998; Whiteneck, Gerhart, & Cusick, 2004) and may also be vulnerable to mood changes. Sander et al. (1997) found unemployed patients reported more difficulties on the NFI Depression and Motor scales and many of the unemployed patients reported difficulties associated with psychomotor problems, such as slowness in movement and thoughts, frustration, impatience, and restlessness. In a sample of 49 individuals with diffuse head injury, unemployed individuals showed significantly higher scores on the BDI than employed or university students (Guth, 2000).

Seel et al. (2003) aimed to identify the factors that contribute to developing depression after TBI in a sample of 666 outpatients, assessed between 10 to 126 months post-injury. Unemployed patients and those who were impoverished at the time of assessment reported significantly more symptoms of a DSM-IV major depressive disorder compared with patients who were employed, retired, or students. Fraunlic, Carvonell, Pinto, and Sepulveda (2004)

examined the employment outcome of 202 TBI patients at 2, 5, and 10 years after TBI and found more severe anxiety and depression symptoms (as measured by the Hamilton Anxiety and Depression Rating Scale [Hamilton 1959; Hamilton 1960] and the Neurobehavioural Rating Scale [Kreutzer et al., 1996]) were reported by unemployed patients compared with employed patients.

As shown above, a number of studies have found a relationship between employment and mood after TBI. Deficits in physical and cognitive functioning are likely to be a barrier to keeping or gaining employment, leading to difficulty in psychological adjustment for the unemployed patient who can no longer work. Patients without employment may also have more time to dwell on the problems associated with their injury than those who are working. No published studies appear to have examined the relationship between SES and emotion following TBI. As brain injury often results in difficulties in occupational functioning (Khan et al., 2003), this could be a possible area for future research.

2.2 Clinical Variables

Mood changes following TBI may be related to clinical variables such as the severity and cause of brain injury, and hospitalisation.

2.2.1 Severity. The severity of TBI may affect patients' emotional outcome (McCleary et al., 1998). Differences in emotion following TBI may be a direct result of the more traumatic nature to the brain that patients with greater TBI severity experience. Alternatively, differences may relate to psychological adjustment to the greater physical and cognitive deficits patients with more severe TBI experience.

Severity of TBI can be measured in a number of ways including level of consciousness (measured by scales such as the GCS; Teasdale & Jennett, 1974) and length of *Post-Traumatic Amnesia (PTA)*. PTA refers to the period of time in which a person is unable to remember events following their injury. The duration of PTA has been suggested to provide a

better indication of functional outcome following TBI, compared to the GCS (Khan et al., 2003).

The most commonly used screening tool for PTA in Australia is the Westmead PTA Scale (Shores, Marosszeky, Sandanam, & Batchelor, 1986): *mild PTA* = less than 1 day, *moderate PTA* = between 1 day and 1 week, and *severe PTA* = greater than 1 week (Ponsford, et al., 2004). However, it remains unclear as to whether there is a relationship between PTA and mood. One study (Skilbeck et al., 2011) found patients with longer PTA showed significantly greater HADS psychomotor and depression scores, but did not significantly differ in HADS anxiety scores.

Studies have found a relationship between emotion and functional outcome after TBI, as measured by the GOS (Asikainen, Kaste, & Sarna, 1998; Jennett, & Bond, 1975). McCleary et al. (1998) found TBI patients with a poor GOS score had a higher frequency of depression symptomatology. Satz et al. (1998) found that in a sample of 100 moderate and severe TBI patients, a significant number of TBI patients who were depressed had poorer GOS outcomes than non-depressed TBI patients and control participants. Additionally, in a larger sample of 939 TBI patients, Fann et al. (2004) found a higher frequency of psychiatric disorders amongst moderate to severe TBI patients (49%) compared with mild TBI patients (34%) during the first year following TBI.

Overall, there are very few studies examining the relationship between severity of head injury and emotion following TBI as studies tend to investigate the emotion of patients within a particular severity group (e.g., depression in severe TBI patients; Hoofien, Gilboa, Vakil, & Donovick, 2001).

2.2.2 Cause of injury. It could be expected that TBI patients whose primary source of injury is an assault or motor vehicle accident display poorer mood than TBI patients with other causes of injury due to the more unexpected and traumatic nature of these types of

injury (Cannan, 2006). However, only a small number of studies appear to have investigated this. Cannan (2006) found that TBI patients injured in motor vehicle accidents and assaults reported significantly more of the emotional symptoms on the Rivermead Post-concussion Symptoms Questionnaire (RPQ) over a 12-month period post-TBI, compared to TBI patients with other causes of injury. Ponsford et al. (2000) explored the factors influencing the psychological functioning of 84 mild TBI patients and 53 adults with other minor injuries. At 3 months post-injury, 24% of the TBI participants were highly distressed. Although no statistically significant differences were found for cause of injury in this distressed group, possibly due to the small sample size, visual inspection of the data indicated motor vehicle accident was the main cause of injury for this subgroup of participants.

In a large-scale study utilizing 1,170 TBI patients, Bushnik, Hanks, Kreutzer, and Rosenthal (2003) found patients involved in motor vehicle accidents tended to suffer more severe injuries but better outcomes at 3 months post-injury. Patients with violence-related causes of injury displayed the poorest outcomes at 1 year following TBI, with higher rates of separation, divorce, and unemployment, and poorer scores on the Community Integration Questionnaire (CIQ; Willer, Rosenthal, Kreutzer, Gordon, & Rempel, 1993). Individuals who are lost to follow-up are more likely to suffer violent injuries, which suggests these findings may be an underestimate (Corrigan et al., 2003).

From the few available studies, there is some suggestion that cause of TBI may play a role in emotional outcome over the course of the first year after injury. Research is needed to determine the nature of this relationship after this 1-year period.

2.2.3 Hospitalisation and orthopaedic injury. TBI patients often sustain injuries to other body parts than the head (Jennett, 1976). This additional injury may be the cause of the patient's admission to hospital and determine their length of stay. TBI patients with severe orthopaedic injury are faced with not only the effects of brain injury but also serious fractures

to parts of their body, resulting in greater physical limitations. Although it could be expected that TBI patients with more severe orthopaedic injury display poorer mood outcome, no published research appears to have examined this.

Generally, TBI patients who spend longer in hospital tend to have more severe injuries, less independence (e.g., wheelchairs and mobility aids), and require rehabilitation in a range of areas such as physical, cognitive, and behavioural domains, with rehabilitation continuing outside of the hospital through outpatient or transitional living facilities (Khan et al., 2003). Due to the range of stressors associated with hospital stay, it could be expected that hospitalised TBI patients have difficulty adjusting to their life after brain injury. However, little research has examined the relationship between length of hospital stay following TBI and mood. In one study, length of acute hospitalisation significantly predicted functional outcome post-brain injury (Spettell et al., 1991). A study by Hawkins, Lewis, Medeiros, and Saffle (2005) found no statistically significant differences in emotional distress between two TBI groups categorised by length of hospitalisation at a Trauma Centre and Rehabilitation Hospital. However, TBI patients with a reduced length of hospital stay tended to exhibit more anxiety symptoms than TBI patients who spent longer in hospital (Hawkins et al., 2005).

2.3 Psychological and Physiological Consequences of TBI

2.3.1 Pain. Patients with TBI often experience pain related to their head injury (e.g., headaches and facial pain) or from physical injuries associated with the accident (e.g., damage to bodily organs and fractures). Pain may be acute or chronic, and has been found to increase an individual's affectivity, leading to a heightened vulnerability to changes in mood (Branca & Lake, 2004; Macdonald & Kingsbury, 2006). Rather than reporting feelings of sadness, some individuals with depression tend to report somatic complaints such as aches and pains (APA, 2013). Depression has been found to occur more frequently in TBI patients with persistent pain (Tyrer & Lievesley, 2003). TBI patients sometimes experience anxiety

that can heighten their perception of pain and affect their ability to cope (Nampiaparampil, 2008).

Studies examining the relationship between head pain and mood have tended to use migraine patients. These studies tend to find that people with migraines have a higher prevalence of depression and anxiety compared with controls (Merikangas & Stevens, 1997). However, some research using TBI samples, have found a relationship between pain and emotion. In a sample of 413 TBI participants, Cannan (2006) found patients who reported high levels of pain within 2 weeks of injury, had higher levels of the emotional symptoms measured by the RPQ, across a 6-month post-injury period.

Bryant, Marosszeky, and Crooks (1999) examined the relationship between pain and PTSD in a sample of severe TBI patients. Ninety-six TBI patients were assessed for pain complaints between 5 and 7 months post-injury on the McGill Pain Questionnaire. A very high incidence of pain complaints was reported in the sample, with chronic pain being reported by 62% of patients. Additionally, 24% of the sample reported daily pain and 7% reported constant pain. The authors found that patients with increased pain tended to experience greater severity in symptoms of PTSD, depression, and life satisfaction, and were more likely to use an avoidant coping style.

Hoffman et al. (2007) found depression (as measured by the Brief Symptom Inventory) was the strongest predictor of participants' scores on the Bodily Pain scale of the Short Form-36 Health Survey, at 1 year post-injury, in a sample of 146 patients with moderate to severe TBI. The results indicated TBI patients with higher levels of depression symptoms at inpatient rehabilitation and at 1 year following injury were more likely to report greater pain at 1 year after TBI.

Overall, pain has been found to relate to emotional outcome over the first year after TBI, but the nature of this relationship is unclear at later time periods.

2.3.2 Fatigue. Fatigue is a common disabling and highly subjective symptom. It refers to a feeling of exhaustion, tiredness, or weakness (Jorge et al., 1993). Fatigue can be related to cognitive impairments that follow head injury. The coping hypothesis (Van Zomeren, Brouwer, & Deelman, 1984) states that fatigue occurs after brain injury due to the additional effort that is required by the patient with cognitive deficits to meet the demands of everyday life. Fatigue can affect a TBI patient's ability to perform activities that were previously automatic. This means that fatigue can affect day-to-day tasks such as concentrating, reading, planning, and performing mental calculations (Crowe, 2008). Due to these problems, it could be expected that the more pain or fatigue a TBI patient is in, the poorer their mood post-injury (Crowe, 2008).

Bushnik, Englander, and Wright (2008) found that depression was one of the most prevalent co-existing disturbances alongside fatigue over a 2-year period following TBI. Englander and Bushnik (2010) found depression was a predictor of fatigue in a sample of 119 TBI patients approximately 1 year post-injury. Fatigue has been found to relate significantly to psychological post-concussion symptoms and impaired quality of life (Stulemeijer et al, 2006). Cannan (2006) found that TBI patients who scored highly on fatigue at 2 weeks post-injury consistently reported emotional post concussion symptoms on the RPQ, over the first year post-injury.

A study by Ouellet and Moirin (2006) found that in a sample of 313 TBI patients, patients suffering fatigue were more likely to have higher scores on the Psychological Distress Index of the Quebec Health Survey (Gervais, Dubé, Dubois, Lavoie, & Julien, 1999). Ziino and Ponsford (2005) administered three subjective measures of fatigue, including the FSS, Visual Analogue Scale-Fatigue (VAS-F), and Causes of Fatigue Questionnaire (COF), to 46 TBI patients and 46 control participants. Higher HADS anxiety and depression scores showed moderate and strong correlations with measures of subjective

fatigue. Bay and Xie (2009) examined the relationship between chronic perceived stress and fatigue in a sample of 75 participants (consisting of TBI patients from outpatient settings and their relatives/significant others). The Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983) was found to account for 40% of the variance in fatigue, more so than depression.

As shown, there is strong support for the notion that fatigue relates to emotional outcome following TBI.

2.3.3 Post-concussion symptoms. Following brain injury, a person's mood may be affected by the presence of post-concussion symptoms. Post-concussion symptoms can last for a long time after a head injury. Often these symptoms resolve within 3 months post-injury, but a significant minority still report symptoms at 12 months and beyond (Rutherford, Merrett & McDonald, 1979). Post-concussion symptoms can be disabling, affecting a patient's ability to return to work and their psychosocial functioning (King, Crawford, Wenden, Moss, & Wade, 1995). These symptoms can lead to emotional complaints such as depression and anxiety (Smith-Seemileer, Fow, Kant, & Franzen, 2003). A TBI patient may become worried about the possible long-lasting effects of these symptoms on their social and occupational functioning, resulting in a feeling of hopelessness about the future.

King (1999) found that patients' scores on the HADS were useful in the prediction of persistent post-concussion symptoms at 3 months after head injury, as measured by the RPQ (King et al., 1995). Gouvier, Cubic, Jones, Brantley, and Cutlip (1992) found that head injury patients experience of post-concussion symptoms was exacerbated by daily stress related to their injury. A recent study by Ponsford, Cameron, Fitzgerald, Grant, Mikocka-Walus, and Schonberger (2012) employing generalized linear models found the strongest predictors of persistent post-concussion symptoms at 3 months following mild-TBI were pre-morbid psychiatric factors and post-injury anxiety (as measured by the HADS). Smith-Seemileer et

al. (2003) found that mild TBI patients with higher levels of psychological distress and perception of blame reported more severe post-concussion symptoms.

Rapoport et al. (2003) found that in the acute period after mild TBI, the incidence of major depression was associated with increased post-concussion symptoms. In a sample of 170 patients with mild TBI, patients with major depression reported higher levels of post-concussion symptoms (Rapoport et al., 2003). In a confirmatory factor analysis study of 170 mild TBI patients by Herrmann, Rapoport, Rajaram, and Chan (2009), *t*-tests showed that patients in the depression group reported more severe levels of post-concussion symptoms across all three factors of the RPQ (Mood and Cognition, General Somatic Symptoms, and Visual Somatic Symptoms).

Risk factors for developing post-concussion symptoms at 3 months following TBI were examined in a prediction study of 115 patients with mild to moderate TBI (McCauley, Boake, Levin, Contant, & Song, 2001). The results of logistic regression analysis showed that patients were three times more likely to report increased levels of post-concussion symptoms if they had a diagnosis of DSM-IV PTSD at 3 months post-TBI. Additionally, higher levels of self-reported depression symptoms at 1 month and 3 months post-TBI was a significant risk factor for increased levels of post-concussion symptoms at 3 months following TBI.

As shown above, research has consistently found a relationship between post-concussion symptoms and emotion after TBI.

2.3.4 Quality of life. Little research has examined the relationship between quality of life and emotion post-TBI, with studies rarely including both a life satisfaction scale and a measure of mood outcome. A study by Thomas (2008) found a relationship between the domains of the HADS and the factors of the Quality of Life Inventory (QOLI; Frisch, Cornell, Villanueva, & Retzlaff, 1992), with significant correlations when the QOLI factors ‘Self-functioning and Activity’ and ‘Self-Actualisation’ were correlated with the HADS

Anxiety, Depression, and Psychomotor factors across a 1-year post-injury period. Steadman-Pare, Colantonio, Ratcliff, and Chase (2001) examined the factors relating to perceived quality of life between 8 and 24 years post-TBI. Two hundred and seventy-five patients with moderate/severe TBI completed the Self-rated Quality of Life Scale. Multivariate linear regression found a number of factors were significantly related to quality of life, including perceived mental health, and the availability of emotional support. Lin et al., (2010) examined the factors associated with health-related quality of life in a sample of 158 TBI patients, over 1 year post-TBI. Depressive status was found to significantly influence changes in the psychological and social domains of the World Health Organization Quality of Life (WHOQOL-BREF; WHO Group; 1998) over the 1-year period, but was not significantly related to the physical and environmental domains.

A longitudinal study by Underhill et al. (2003) assessed the relationship between depression and life satisfaction between 2 to 5 years following TBI. At each of the assessments, the depressed group of TBI patients was found to have significantly lower life satisfaction compared with the group of TBI patients without depression. Von Steinbuchel, et al. (2010) explored the life satisfaction of 795 adults, 3 months to 15 years post-TBI. The HADS depression and anxiety scores were found to be two of the main negative correlates of quality of life, indicating emotional state was related to life satisfaction after TBI.

Although TBI research suggests a relationship between quality of life and mood, studies have mainly focused upon quality of life measured after brain injury (often after years have passed), rather than patients' pre-morbid quality of life. Given there are scales designed to also measure pre-morbid quality of life (e.g., the QOLI; Frisch et al., 1992), this is a possible area of study for future research.

2.4 Predictors of Mood Outcome Following TBI

Predicting mood outcome after TBI is an important area of research because accurate prediction is useful in directing treatment, determining prognosis, and providing accurate information on expectations to the patient and their relatives and caregivers (Brown et al., 2005). For accurate prediction of outcome, multiple risk factors need to be considered, as single risk factors tend not to distinguish between TBI patients who will show good recovery and patients who will show poor recovery (Mushkudiani, Hukkelhoven, Hernandez, Murray, Choi, Maas & Steyerberg, 2008). There are a number of different methods researchers use to create models for prediction of outcome post-TBI, such as linear and logistic regression, regression trees, neural networks, and discriminant function analysis (Mushkudiani et al., 2008; Ponsford et al., 2000). A systematic review by Mushkudiani (et al., 2008) found the most common statistical techniques were linear and logistic regression with stepwise method of selection.

Studies have tended to focus on variables that predict physical outcome after TBI (Brown et al., 2005; Katz & Alexander, 1994) or predictors of mood outcome following other injuries and illnesses (Leentjens, Aben, Lodder, & Verhey, 2006; Schnyder, Moergeli, Trentz, Klaghofer, & Buddeberg, 2001). Prediction of emotional recovery after TBI is a relatively new area of research with most of the studies conducted in the 2000s. Of the available studies examining predictors of mood post-TBI, most have focused on predicting depression. Douglas and Spellacy (2000) administered the Self-Rating Depression Scale (SDS) to 35 individuals with severe TBI and found the variables gender, marital status, disability level, and social support predicted most of the variability in depression. However, the results of this study should be interpreted with caution due to the small sample size and the inclusion of only severe TBI patients. Levin, McCauley, Pedroza, Corwin, and Brown (2005) found that in a sample of 129 TBI patients, those at greater risk of major depression

were older, had an abnormal CT scan result, and a high depression score at 1 week post-TBI. Older patients and patients with subdural haemorrhage were at greater risk of developing depression within 1 year post mild TBI, in a logistic regression study of 43 mild TBI patients (Rao et al. 2010). A large-scale study of 1,560 adult TBI patients by Horner, Selassie, Lineberry, Ferguson, and Labbate (2008) found the primary risk factors for developing psychological symptoms post-TBI were age, physical functioning, social support, ethnicity, and gender. Other risk factors were employment, multiple concussions, and pre-morbid psychiatric disorder (Horner et al., 2008).

Other types of emotional outcome (such as anxiety and stress) have been examined. A multiple regression analysis of the data from 75 adult TBI outpatients showed that the frequency of brain injury symptoms explained the variability in the TBI patients' anxiety/tension, anger/hostility, and perceived stress (Bay & Bergman, 2006). In a sample of 99 TBI participants, Kendall and Terry (2009) found family support directly affected patients' emotional wellbeing, and patients with higher levels of self-esteem and financial security showed lower perceived threat and higher levels of emotional wellbeing, in both the short- and long-term post-TBI. In a sample of 88 moderate/severe TBI patients, Demakis, Hammond, and Knotts (2010) found a combination of the predictor variables age, sex, employment, marital status, and length of loss of consciousness explained 14% of the variance in scores on the Personality Assessment Inventory (PAI; Morey, 1991) Anxiety scale and 17.7% of the variance in scores on the Anxiety-Related Disorders scale, but did not significantly predict scores on the Depression scale.

Prediction of mood outcome post-TBI is a relatively recent area of study and there appears to be little consensus in the literature as to the factors that provide the best prediction. Furthermore, there is a gap in the literature examining the prediction of mood beyond 1 year post-TBI.

Chapter 3

The Hospital Anxiety and Depression Scale (HADS)

3.1 Background to the HADS. The HADS (Zigmond, & Snaith, 1983) is a brief questionnaire frequently administered to individuals with physical illness (Snaith, 2003; Smith et al., 2002). The questionnaire was developed as a screening tool for use in any general medical setting and contains two subscales, an anxiety subscale and a depression subscale (Snaith & Zigmond, 1994). It was designed to exclude symptoms that may arise from the somatic aspects of illness, such as headaches, dizziness, insomnia, and fatigue (Barth & Martin, 2005).

When an individual has a physical illness or injury, they are administered the HADS to determine if they have experienced mood changes following their disability (Snaith, 2003). A patient's score on the HADS can be extremely useful for assessing their rehabilitation needs. The HADS is an appropriate questionnaire for non-psychiatric populations (Zigmond & Snaith, 1983). It taps into emotional difficulties, whilst refraining from focusing on the more sensitive psychiatric areas that other questionnaires measure. For example, the BDI II (Beck, Steer, & Brown, 1996) has items relating to suicide, feelings of worthlessness, and self-dislike.

The HADS contains 14-items and usually takes between 2 to 5 minutes to complete (Zigmond & Snaith, 1983). The participant is presented with a series of items and asked to respond to each item based on a 4-point Likert scale (range 0 to 3; Desmond & MacLachlan, 2005). The respondent is asked to answer according to how they have been feeling in the past week (Zigmond & Snaith, 1983). The subscale scores are determined by adding the numbers in the Anxiety and Depression columns, which produces scores ranging from 0–21 for each subscale. These scores are interpreted by: 0–7 = *normal*, 8–10 = *mild*, 11–14 = *moderate*, and

15–21 = *severe symptoms*. Scores above 10 on the subscales are within the clinical range (Snaith & Zigmond, 1994).

The internal consistency of the HADS has been found to range from satisfactory to excellent. A study by Moorey, Greer, and Watson (1991) administered the questionnaire to 568 cancer patients. Cronbach's alpha was found to be 0.93 for the anxiety scale and 0.90 for the depression scale. A more recent study by Woolrich, Kennedy, and Tasiemski (2006) found the HADS contained good internal consistency, with a Cronbach's alpha of 0.85 for the anxiety scale and 0.79 for the depression scale.

The HADS has good face validity, takes little time to complete and is easy to administer. Numerous studies have found support for the concurrent validity of the instrument (Bramley, Easton, & Morley, 1988; Zigmond & Snaith, 1983). Zigmond and Snaith (1983) correlated the HADS with a five-point psychiatric rating scale of anxiety and depression in a sample of 100 medical outpatients. Significant correlations were found of 0.54 for the anxiety scale and 0.79 for depression scale.

Upadhyaya and Stanley (1993) examined the concurrent validity of the HADS in a sample of 110 individuals attending a general practice setting. Correlations were conducted between the HADS and the Montgomery-Asberg Rating Scale for Depression (MADRS; Montgomery & Asberg, 1979) and the Clinical Anxiety Scale (CAS; Thyer, 1992). A Spearman correlation coefficient of 0.75 was found between the anxiety subscale of the HADS and the CAS score. The Spearman correlation coefficient found between the depression subscale of the HADS and the MADRS score was 0.80. Both of these correlation coefficients were highly significant, suggesting the HADS provides valid measures of the severity of anxiety and depression mood states.

The reliability and validity of the HADS has been explored in a number of detailed literature reviews. Hermann (1997) investigated the results of approximately 35,000 medical

patients from approximately 200 articles on the HADS. Overall, it was found the HADS was a reliable and valid instrument suitable for measuring anxiety and depression in a wide range of medical populations. However, this review did not include samples taken from the general population, affecting the generalisability of the results. A larger and more recent review of 747 papers found the HADS performed well when used with a range of populations (Bjelland, Dahl, Haug, & Neckelmann, 2002). The results supported the findings of Hermann (1997) as the instrument was found to contain good internal consistency and concurrent validity in psychiatric, somatic, and primary care patients. Additionally, the HADS was found to perform well in the general population.

3.2 The HADS and the Assessment of Mood Post-TBI. The HADS is often used by clinicians to screen for psychological problems after TBI. However, very few studies have actively investigated the suitability of the HADS with this clinical population, which is an area of more recent research. Al-Adawi et al. (2007) examined the effectiveness of an Arabic translation of the HADS in diagnosing psychological disorders in a sample of 68 mild to severe TBI Arabic patients. Receiver Operating Characteristic (ROC) curve analysis was employed to examine the relationship between the HADS anxiety and depression subscales and the presence of anxiety and depression diagnosed by the Composite International Diagnostic Interview (CIDI; World Health Organization, 2000). Poor sensitivity and specificity trade-offs were found, suggesting the HADS was ineffective in predicting diagnoses on the CIDI in an Arabic sample. These findings should be interpreted with caution due to the translation of the HADS into a foreign dialect and cultural differences in the expression of emotion.

A study by Whelan-Goodinsona, Ponsford, and Schonberger (2009) found the HADS was a reliable and valid measure of emotional distress in a sample of 100 mild to severe TBI patients. The HADS anxiety, depression, and total scales were found to be homogenous based

on Cronbach's alpha. ROC curve analysis found good sensitivity and specificity when HADS scores were compared with patient diagnoses on the Structured Clinical Interview for DSM-IV (First, Spitzer, Gibbon, & Williams, 1996). The results of this study are difficult to generalise to the entire TBI population, as participants were mostly moderate and severe TBI patients. Schonberger and Ponsford (2010) examined the factor structure of the HADS in a sample of 294 TBI patients. Confirmatory factor analysis was performed to determine whether a one-, two-, or three-factor solution provided the best fit for the HADS. A three-factor solution of the Clark and Watson (1991) Tripartite Model of Depression and Anxiety showed the best fit. However, only minor differences between the one-, two-, and three-factor models were found.

3.3 Assessing Psychomotor Symptoms After TBI. Studies have tended to focus mainly on the occurrence of anxiety and depression post-TBI rather than psychomotor changes. Although TBI patients experience symptoms of psychomotor agitation and retardation post-injury, it seems there are few scales designed specifically to assess these symptoms (Lemke, Puhl, Koethe, & Winkler, 1999). Of concern, Fugate et al. (1997) found that in a sample of 157 psychiatrists (both general and those who specialised in the treatment of brain injury), the majority did not formally measure agitation with brain injury patients.

However, recent research suggests the HADS may be an appropriate questionnaire to measure psychomotor symptoms in TBI patients (Skilbeck et al., 2011). The HADS has been found to provide a measure of anxiety and depression in people, which may coexist as a manifestation of physical illness (Martin, Tweed, & Metcalfe, 2004). Recent studies applying exploratory and confirmatory factor analysis have found the HADS may also provide a measure of psychomotor symptoms in different clinical populations (Friedman, Samuelian, Lancrenon, Even, & Chiarelli, 2001; Martin, Lewin, & Thompson, 2003).

Friedman et al. (2001) investigated the factor structure of the HADS in a large French population of primary care outpatients treated for major depression. Principal component analysis was performed on the data from 2,669 patients. It was found the data was best explained by three distinct factors: a Depression factor, Psychic Anxiety factor, and a Psychomotor Agitation factor, which together explained 48% of the variance. The three-factor solution was found to be reliably robust and provided the best fit when both orthogonal and oblique rotations were used. Furthermore, a three-factor solution provided the best fit in a number of samples, including a sample of men, a sample of women, and two samples randomly selected (*N1* = 1,335 patients, *N2* = 1,334 patients).

Martin et al. (2003) administered the HADS to 335 coronary care patients following diagnosis of acute myocardial infarction (MI). Confirmatory factor analysis was used to test several models constructed based on prior research. An advantage of this study was that these models were tested at three different time points: within 1 week of MI, 6 weeks post-MI, and 6 months post-MI. The three factor models of Dunbar, Ford, Hunt, and Der (2000) and Friedman et al. (2001) consistently provided a superior fit at all observation points. Both of these models contained a psychomotor type factor. Using both exploratory and confirmatory factor analysis, Barth and Martin (2005) found the HADS measured psychomotor agitation, psychic anxiety and depression in a sample of 1,320 German coronary heart disease patients.

Holm (2006) and Skilbeck et al. (2011) aimed to identify the underlying factor structure of the HADS in a sample of 371 TBI participants (see Appendix A for published journal article of Skilbeck et al., 2011). One-month follow-up data was used, allowing inclusion of severe TBI patients while still being early post-injury. A two- and a three-factor model were compared using exploratory (EFA) and confirmatory (CFA) factor analysis. While EFA suggested two-factor (Anxiety, Depression) and three-factor (Anxiety, Psychomotor, and Depression) structures provided adequate descriptions, CFA strongly supported the three-

factor model (See Figure 3.1). The majority of the items loading onto the psychomotor factor reflected general psychomotor disturbance, consisting of items that related to both agitation and retardation. This was a unique finding, as the third factor found in many studies on the HADS solely measures psychomotor agitation.

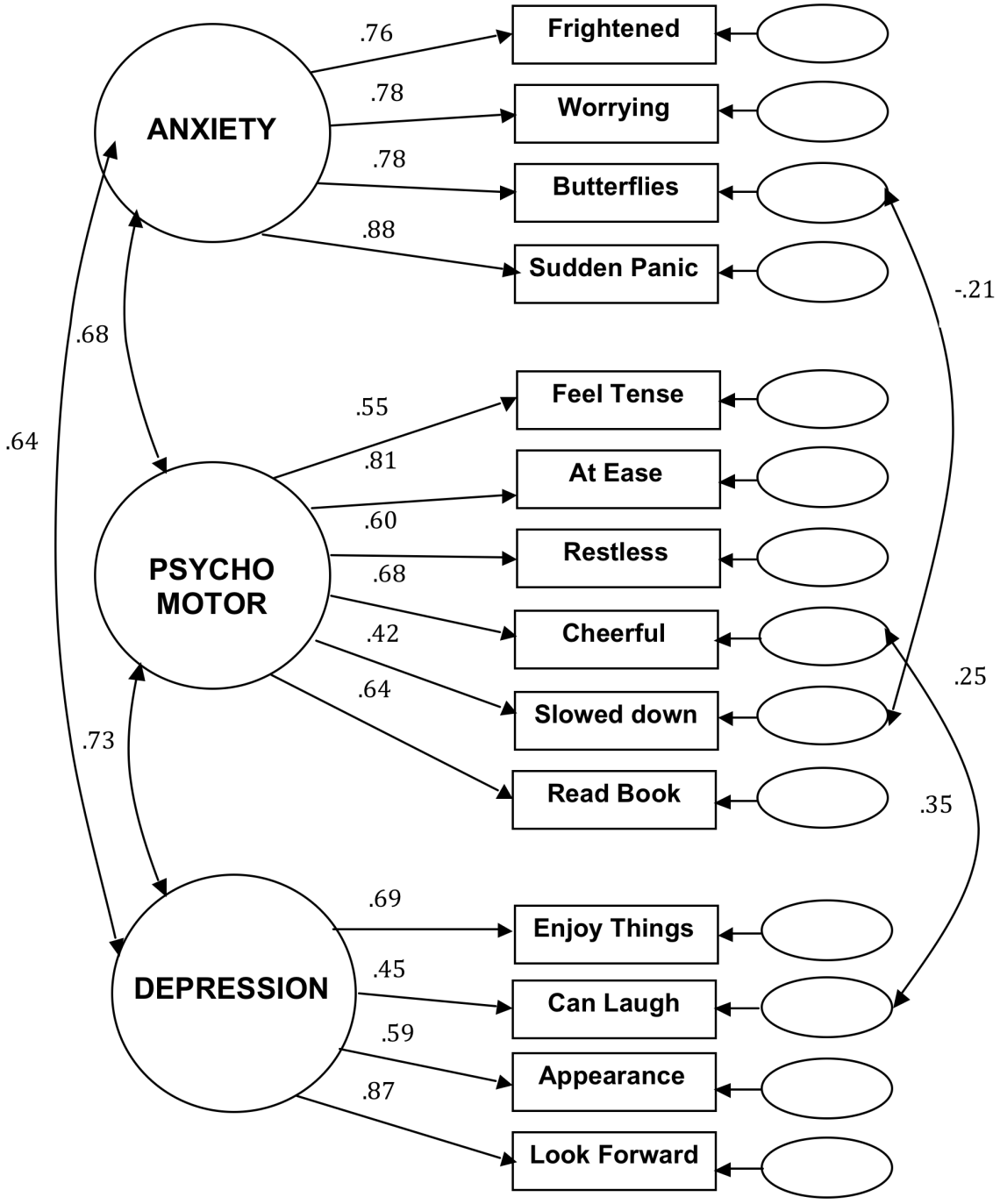

Figure 3.1. HADS 3-factor model of Skilbeck et al. (2011).

3.4 Predictors of HADS Scores Following TBI

The HADS has been used in the prediction of anxiety and depression scores in a range of clinical populations, such as breast cancer patients (Vahdanimia, Omidvari, & Montazeri, 2010), epilepsy patients (Mensah, Beavis, Thapar, & Kerr, 2006), abdominal surgery patients (Carr, Thomas, & Wilson-Barnet 2005), intensive care patients (Rattray, Johnston, & Wildsmith, 2005), and patients with facial arthromyalgia (Madland, Feinmann, & Newman, 2000). However, although the HADS has been found to provide a valid measure of emotional recovery following TBI (Schonberger & Ponsford, 2010; Skilbeck et al., 2011), it appears no research has examined the prediction of HADS scores within the TBI clinical group.

Chapter 4

The Present Research

The emotional outcome of TBI patients is an essential area of study due to the high prevalence of mood disturbances following TBI and the detrimental impact of these problems on the lives of patients. However because there is a lack of clinical studies focusing on mood recovery after TBI, the present study aims to explore the mood recovery patterns of patients after TBI, to provide a baseline to guide early therapeutic interventions.

As discussed in Chapter 2, the literature has suggested a large number of variables may relate to emotional outcome after TBI, including demographic, clinical, and the psychological/physiological consequences of TBI. Although there is strong support for a relationship between emotion and particular variables (e.g., pain, fatigue, and quality of life), there are also significant gaps in the literature (e.g., SES and orthopaedic injury). Furthermore, studies investigating differences in emotional recovery tend to focus on outcome at a specific time point after TBI (often soon after injury), consist of small sample sizes, or use only a specific severity group of participants (e.g., mild TBI or moderate/severe TBI patients). Therefore, a model is needed to explain the relationship between these variables and the mood outcome of TBI patients in the immediate, short-, and long-term post-injury.

Figure 4.1 displays a model of the variables suggested to affect mood after TBI. The present research aims to investigate this model by extending the research of Holm (2006), and Skilbeck et al. (2011; see Appendix A for an electronic version of this paper). Holm (2006), and Skilbeck et al. (2011), in a sample of 371 TBI participants examined the HADS factor structure and the effects of a small number of variables (TBI severity, gender, and age) on HADS factor scores over a 1-year period. Consistent with these previous studies, the present research will also use data collected at the Neuro Trauma Register (NTR) for the

analyses. However due to the availability of more recent data and the sheer size of this PhD research, the present thesis will contain a larger total sample size and will provide a more detailed exploration of changes in patients' HADS scores over a longer time period post-TBI.

The present research is a population study that will utilise a very large sample size, consisting of TBI participants taken from a database of 1,260 cases, with severity of TBI ranging from mild to severe. The HADS three-factor model of Anxiety, Depression, and Psychomotor found by Holm (2006) and Skilbeck et al. (2011) will be used to explore participants' emotional recovery at six follow-up assessments over 2 years post-injury, to determine differences according to the demographic, clinical, and psychological/physiological variables shown in Figure 4.1. Furthermore, the research aims to determine which of these variables gathered at the initial and 1-month follow-up assessments, can be used to best predict participants' emotional recovery at later assessments. This knowledge will assist clinicians in identifying patients requiring psychological intervention from their data gathered at early time periods post-TBI.

Rather than using Holm's (2006) method of transforming raw scores into scaled scores (Stens), the present research will analyse the data using factor-weighted summed item scores, to enhance the clinical meaning of the factor scores (Cheung, 2002; Thomas, 2008). This will allow patient scores to be compared with the item-level normative data from a large non-clinical community based sample of 2,547 participants (Dunbar et al., 2000). In large TBI studies, participant drop-out is often not random and may be related to a number of factors (Langley, Johnson, Slatyer, Skilbeck, & Thomas, 2010). To determine whether there are differences on the HADS based upon participant drop-out, the present study will include both *cross-sectional sample* analyses of participants' HADS data at isolated follow-up assessments and *longitudinal sample* analyses of the HADS data of participants who came to each follow-up assessment.

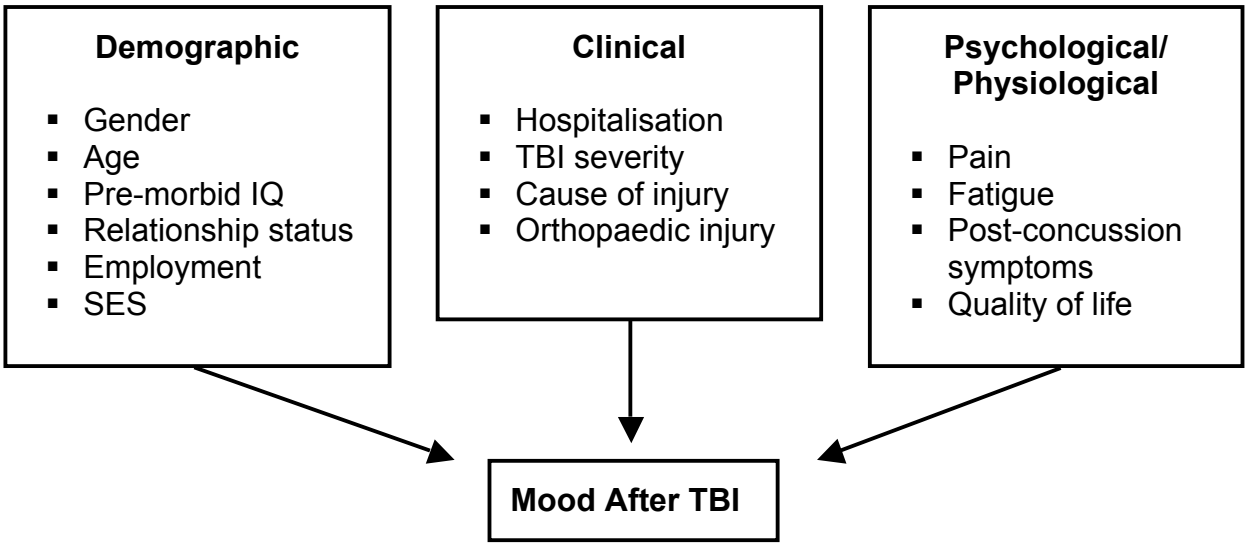

Figure 4.1. A model of the variables expected to affect mood post-TBI.

Chapter 5

Study 1 - Relationship Between Demographic Variables and Mood

As discussed in Chapter 2, a number of demographic variables have been suggested to influence mood outcome following TBI. The present study aimed to examine differences in TBI participants' scores on the HADS based on the demographic variables: age, gender, pre-morbid intelligence, relationship status, employment status, and SES.

5.1 Hypotheses

1) *Gender*: Female TBI patients will score higher on the HADS factors than male TBI patients (Chapter 2 – Section 2.1.1).
2) *Age:* Older TBI patients will score higher on the HADS factors than younger TBI patients (Chapter 2 – Section 2.1.2).
3) *Pre-morbid intelligence*: TBI patients with lower pre-morbid intelligence will score more highly on the HADS factors compared with TBI patients with higher pre-morbid intelligence (Chapter 2 – Section 2.1.3).
4) *Relationship status:* TBI patients in a significant relationship will score lower on the HADS factors (Chapter 2 – Section 2.1.4).
5) *Employment status:* Unemployed TBI patients will display higher scores on the HADS factors (Chapter 2 – Section 2.1.5).
6) *SES:* Participants with lower SES will score more highly on the HADS factors (Chapter 2 – Section 2.1.5).
7) *Multiple regression:* Multiple regression will be performed to identify which demographic variables measured at the initial and 1-month follow-up will significantly predict the HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI (Chapter 2 – Section 2.4).

5.2 Method

5.2.1 Participants. There were 1,260 cases identified from a database at the Neuro Trauma Register. From these cases, 216 participants were excluded, as they did not attend follow-up assessments within defined periods of time post-TBI (see Section 5.2.6 'Data screening'). The final total sample for Study 1 consisted of 1,044 participants (aged 16–91 years) who completed the HADS following a TBI. Due to missing data at each follow-up assessment, the numbers of participants varied in the analyses (N = 202–596; see Figure 5.1). The sample sizes of the group tended to differ. For example, there were fewer participants in the unemployed group (n = 37–178) than the employed group (n = 202–349), which reflects the lower number of unemployed participants in the total sample, but may also be explained by unemployed participants difficulty attending assessments at the Neuro Trauma Register due to costs, such as money and time.

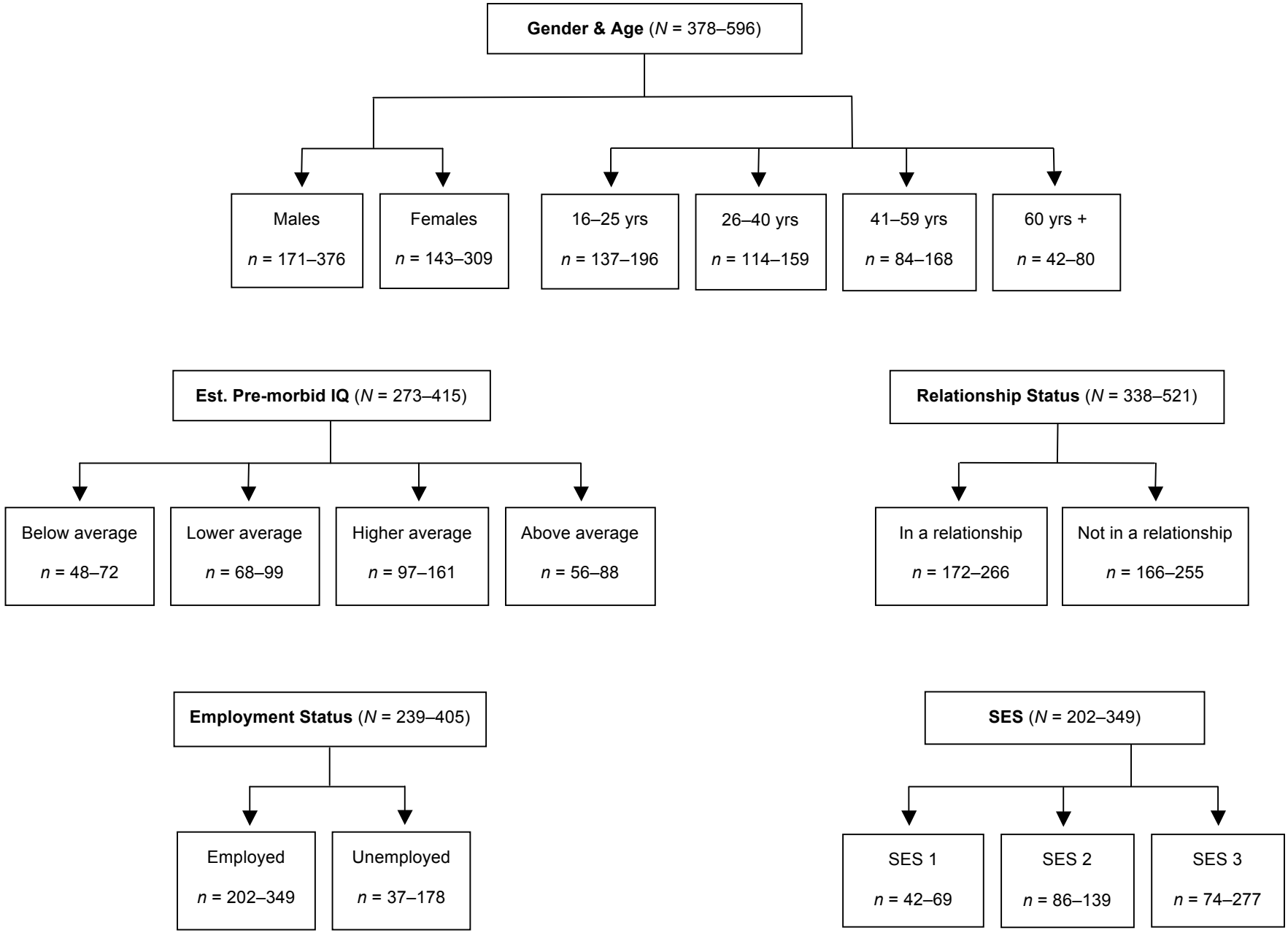

Figure 5.1. Participant numbers for the cross-sectional sample analyses reported in Study 1.

5.2.2 Materials. Screening materials included the Westmead PTA Scale (Shores et al., 1986) and the Galveston Orientation and Amnesia Test (GOAT; Levin, O'Donnell, & Grossman, 1979). The Westmead PTA Scale is an objective measure of length of PTA. It has 12 questions overall, consisting of 7 orientation and 5 memory questions. The respondent is thought to be no longer in PTA if they achieve a perfect score of 12 on three consecutive days. The GOAT consists of 10 questions, designed to assess PTA. It is scored on a scale of 0 to 100. A score above 75 is required for a patient to be deemed out of PTA.

Participants completed the Neuro Trauma assessment, a battery of neuropsychological tests and questionnaires, including the HADS (Zigmond & Snaith, 1983), and the National Adult Reading Test Revised (NART-R; Nelson & Willison, 1991a). Questions relating to age, gender, relationship status, and employment were also included in the schedule.

The HADS is a 14-item questionnaire, which usually takes between 2 to 5 minutes to complete. The participant is presented with a series of items (see Table 5.1) and asked to respond to each item based on a four-point Likert scale (range 0 to 3; Desmond & MacLachlan, 2005), according to how they have been feeling in the past week (Zigmond & Snaith, 1983). In its original form, the HADS contains two subscales, an anxiety scale and a depression scale. However, in the present research, participants' scores on the items were converted to factor scores using the Skilbeck et al. (2011) 3-factor model (see Section 5.2.5 'Data Analysis').

Table 5.1

Items in the HADS (Zigmond & Snaith, 1983)

HADS Item
Anxiety Subscale
• I feel tense or wound up
• I get a sort of frightened feeling as if something awful is about to happen
• Worrying thoughts go through my mind
• I can sit at ease and feel relaxed
• I get a sort of frightened feeling like 'butterflies' in the stomach
• I feel restless as if I have to be on the move
• I get sudden feelings of panic
Depression Subscale
• I still enjoy the things I used to enjoy
• I can laugh and see the funny side of things
• I feel cheerful
• I feel as if I am slowed down
• I have lost interest in my appearance
• I look forward with enjoyment to things
• I can enjoy a good book or TV programme

The NART-R provides an estimate of an individual's pre-morbid intelligence (Nelson & Willison 1991b). The respondent is required to read aloud a list of 50 irregularly spelled words. The number of errors obtained is used to calculate the individuals' estimated Verbal IQ, Performance IQ, and Full Scale IQ.

5.2.3 Procedure. Participants were recruited following their attendance at the Emergency Room in the Royal Hobart Hospital. They were contacted as close to the injury as possible by a research assistant, either on the hospital ward, or by telephone if they were not admitted or already discharged. Potential participants were invited to join the study if they were found to suffer a head injury according to International Classification of Diseases (ICD) TBI codes. Before participating, patients on the hospital ward were required to attain a perfect score on the Westmead PTA Scale, thus indicating they were no longer in PTA. Additionally, participants were administered the GOAT by NTR staff. Participants were

required to have a score exceeding 75 before commencing testing, indicating they were oriented and out of PTA. Information regarding patients' ethnicity, primary language, and developmental history was unavailable for the present study. However, research assistants did not administer the NART-R when it was likely that a participant would have had difficulty completing the test due to a non-English speaking background or learning difficulty (Nelson, & Willison, 1991b).

All participants were provided with an information sheet and were required to sign a consent form (see Appendix A). A parent/guardian signature was required for participants under the age of 18 (Appendix A). Participants attended a number of follow-up assessments following their head injury: the initial (baseline) assessment and further assessments at 1 month, 3 months, 6 months, 12 months, and 24 months post-injury. At each follow-up, participants completed the Neuro Trauma assessment, which included the HADS and demographic questions. The NART-R was administered at the initial follow-up to estimate participants' pre-morbid level of intelligence. The current research is part of a wider research project and subsequently other researchers were also involved in some data collection.

To ensure confidentiality, the identities of participants are protected using hospital patient numbers (URN, 2003) and study numbers. Scores on neuropsychological and medical tests and questionnaire forms are held in a secure location and participant scores kept in a secure electronic database. Approval was obtained from the Human Research Ethics Committee (HREC) prior to data gathering (H7116).

5.2.4 Design. Both a between subjects design with repeated measures ANOVA, and a between-subjects ANOVA design were employed. The between-subjects independent variables were age, gender, the NART-R, relationship status, employment status, and SES. The within-subjects independent variable was time since TBI. The Anxiety, Depression, and Psychomotor HADS factor scores were the dependent variables.

A multiple regression design was also employed to examine whether demographic variables at the initial and 1-month follow-up assessments could be used to predict mood outcome at the 3-, 6-, 12-, and 24-month follow-ups. As the multiple regression analyses in the present study were exploratory, different variants of the variables were included in the analyses (e.g., age in years and age in groups). The independent variables (predictor variables) are listed below. The HADS Anxiety, Depression, and Psychomotor raw factor scores (Skilbeck et al., 2011) were the dependent variables (outcome variables).

Demographic Predictor Variables:

- Age (years)
- Age 4 groups (16–25 years; 26–40 years; 41–59 years; 60 years +)
- Gender (male/female)
- NART FSIQ
- NART 2 groups (NART < 100; NART > = 100)
- NART 4 groups (below average IQ; lower average IQ; higher average IQ; above average IQ)
- Employment 2 groups (employed/unemployed)
- SES 3 groups (SES 1 = employed in professional or managerial roles; SES 2 = employed in associate professional or skilled roles; SES 3 = employed in semi-skilled or unskilled roles)
- Relationship Status 2 groups (in a relationship; not in a relationship)

5.2.5 Data analysis. Following completion of the HADS by participants at each follow-up, item scores were transferred to an SPSS computer file. Factor scores were then computed for the Anxiety, Depression, and Psychomotor factors (Chapter 3 – Figure 3.1). The raw factor score was the score for each item multiplied by its loading on that factor (Skilbeck et al., 2011) added together:

e.g., Anxiety Factor = (score on 'I get a sort of frightened feeling as if something awful is about to happen' x 0.76) + (score on 'Worrying thoughts go through my mind' x 0.78) + (score on 'I get a sort of frightened feeling like butterflies in the stomach' x 0.78) + (score on 'I get sudden feelings of panic' x 0.88)

Two types of analyses were conducted to compare groups' HADS scores using IBM SPSS Statistics version 20.0: *Longitudinal Sample* (N = 55–101; repeated measures analysis of variance [ANOVAs] on the data of the participants who came to every follow-up), to assess change/recovery in mood over 24 months post-TBI; *Cross-sectional Sample* (N = 202–596; independent samples *t*-tests and one- and two-way ANOVAs on the data of all participants attending a specific follow-up point [e.g., initial assessment]). When power and effect sizes were not provided by SPSS, these were calculated using the statistical program G*Power Version 3.1.5.1 (Erdfelder, Faul, & Buchner, 1996). The analyses were performed using the independent variables of age, gender, the NART-R, relationship status and occupation, the HADS factor scores as dependant variables, and the time periods post-injury (repeated measures).

The assumptions were tested for each of the statistical analyses. For the cross-sectional sample ANOVAs, where Levene's test of equality of error variances was significant (p < .05), the Brown-Forsythe statistics were adopted. *T*-tests with significant Levene's test for equality of error variances were adjusted by reporting 'equal variances not assumed.' For the longitudinal sample analyses, the assumption of equality of covariance matrices was examined using Box's M statistic. Where Box's M was significant (p < .001), a more stringent alpha level was adopted (p < .01) to determine statistical significance for the tests of within-subjects effects. Where Mauchley's Test of Sphericity was significant (p < .05), Greenhouse-Geisser statistics were reported. For the correlational and multiple regression

analyses, preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity (see 'Output – Study 1' in Appendix B on the CD).

To examine the relationship between the predictor variables and the dependent variables, preliminary regression analyses involved entering all predictor variables into the equation. Stepwise regression was then conducted as an exploratory procedure, where variables were selected based upon mathematical criteria (Tabachnick & Fidell, 2000). Probability of .15 for entry was chosen as Bendel and Afifi (1977 cited in Tabachnick & Fidell, 2000) recommended a liberal criterion for entry in order to capture important variables that would otherwise be excluded from the model. Cohen's (1988) guidelines for measuring effect size were used to interpret the strength of the relationships between the demographic predictor variables and the HADS factors (*small*: r = .10 to .29; *medium*: r = .30 to .49; *large*: r = .50 to 1.0).

5.2.6 Data screening. The data was examined for values that fall outside the range of possible values, indicating data entry errors, and no evidence of outliers more than 3 standard deviations away from the mean was found. Participants were only included in this study if they attended follow-up assessments within defined time periods post-TBI. These were: the initial follow-up assessment (1–14 days post-TBI), 1-month follow-up (21–38 days), 3-month follow-up (61–121 days), 6-month follow-up (122–240 days), 12-month follow-up (300–420 days), and 24-month follow-up (631–900 days).

To identify whether gender and NART were confounding variables with age, a series of analyses were performed for each of the HADS factors at the initial follow-up assessment (see 'Output – Study 1' in Appendix B on the CD). The results of independent samples *t*-tests showed the NART did not account for significant differences in any of the HADS scores when age was included ($p > .05$). However, one-way ANOVAs found that gender accounted for significant differences in the HADS anxiety and depression scores when age was included

in the analyses ($p < .01$). These results suggested that age and gender should be analysed together to control for the confounding influence of gender and to allow the interaction between these two variables to be examined.

5.3 Results

5.3.1 Descriptive Statistics

Table 5.2 displays means, medians, standard deviations, percentages, and ranges for the demographic variables in the cross-sectional (i.e., total sample – participants who were found to have a HADS score at the initial follow-up assessment) and longitudinal samples. As shown in Table 5.2, similar descriptive statistics were found for both samples. However, participants in the longitudinal sample had only slightly higher mean and median ages, and a reduced length of PTA, when compared with the cross-sectional sample.

In both samples, there were a higher proportion of males and younger participants (below the age of 40 years) and the majority of participants (approximately two-thirds) had mild TBI—these findings are consistent with previous research on TBI (Khan et al., 2003). Participants' mean estimated pre-morbid intelligence was approximately mid average range. At the initial follow-up assessment, the majority of the participants were employed and half of the participants were in a relationship.

Table 5.2

Descriptive Statistics for Demographic Variables

Characteristic	*Mdn*/%	*M*	*SD*	Range
Cross-sectional Sample				
Gender – Males	65%			
Age (years)	31.97	36.11	16.57	16–91
NART FSIQ	100	99.23	10.62	73–122
PTA (days)	.04	2.20	6.69	0–60
PTA - Mild	72%			
In a Relationship	51%			
Employed	84%			
Longitudinal Sample				
Gender – Males	58%			
Age (years)	37.95	40.74	18.82	16–85
NART FSIQ	104	102.77	9.69	78–122
PTA (days)	.03	.46	.94	0–5
PTA - Mild	81%			
In a Relationship	58%			
Employed	89%			

Note. NART FSIQ = National Adult Reading Test Full Scale Intelligence Quotient.

5.3.2 Gender and Age

Cross-sectional sample. To explore the impact of gender and age on mood post-TBI, two-way between-subjects ANOVAs were conducted on the HADS data at each separate follow-up assessment, over 2 years post-TBI. Following a frequency analysis, the most comprehensive way of analysing the data while keeping adequate cell sizes, was to split the sample into six groups, based upon participants' gender (males/females) and age (16–35 years, 26–40 years, 41–59 years, and 60 years +; Skilbeck et al., 2011). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and

ranged from 378 to 596 participants: males (*n* = 171–376), females (*n* = 143–309), 16–25 years (*n* = 137–196), 26–40 years (*n* = 114–159), 41–59 years (*n* = 84–168), and 60 years + (*n* = 42–80; see Figure 5.1).

Table B1 and B2 (Appendix B) display the mean HADS factor scores and standard deviations from these analyses. The mean scores for gender are plotted in Figure 5.2 (for the Anxiety factor) and in Figures B1 and B2 in Appendix B (for the Depression and Psychomotor factors). The mean scores for age are plotted in Figures B3 and B4 in Appendix B (for the Anxiety and Depression factors) and Figure 5.3 (for the Psychomotor factor).

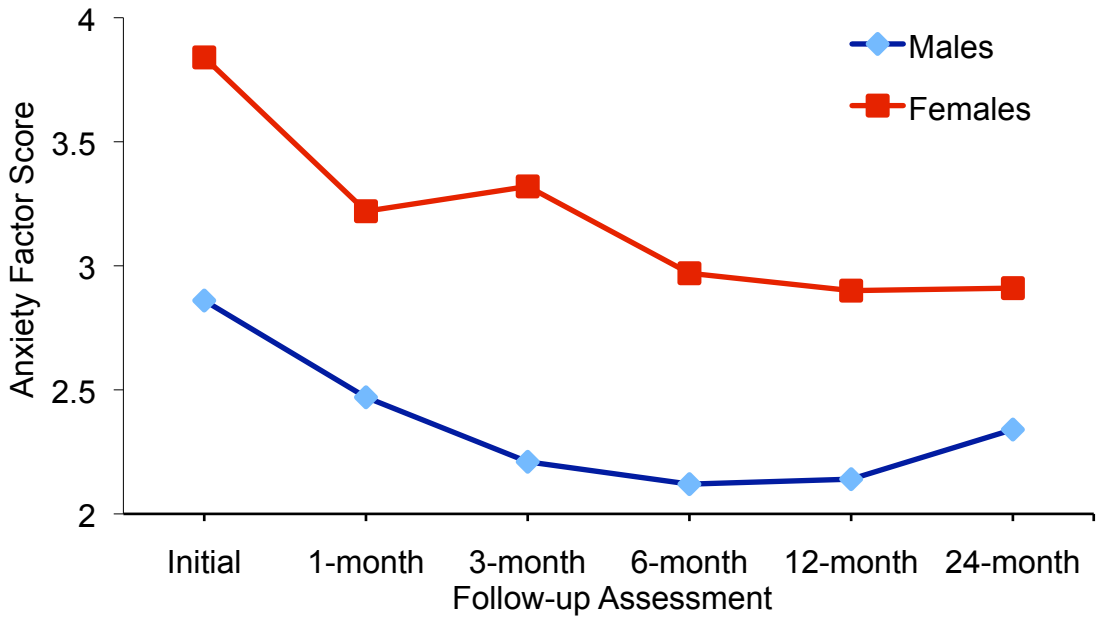

Figure 5.2. Mean anxiety factor scores for gender (cross-sectional sample).

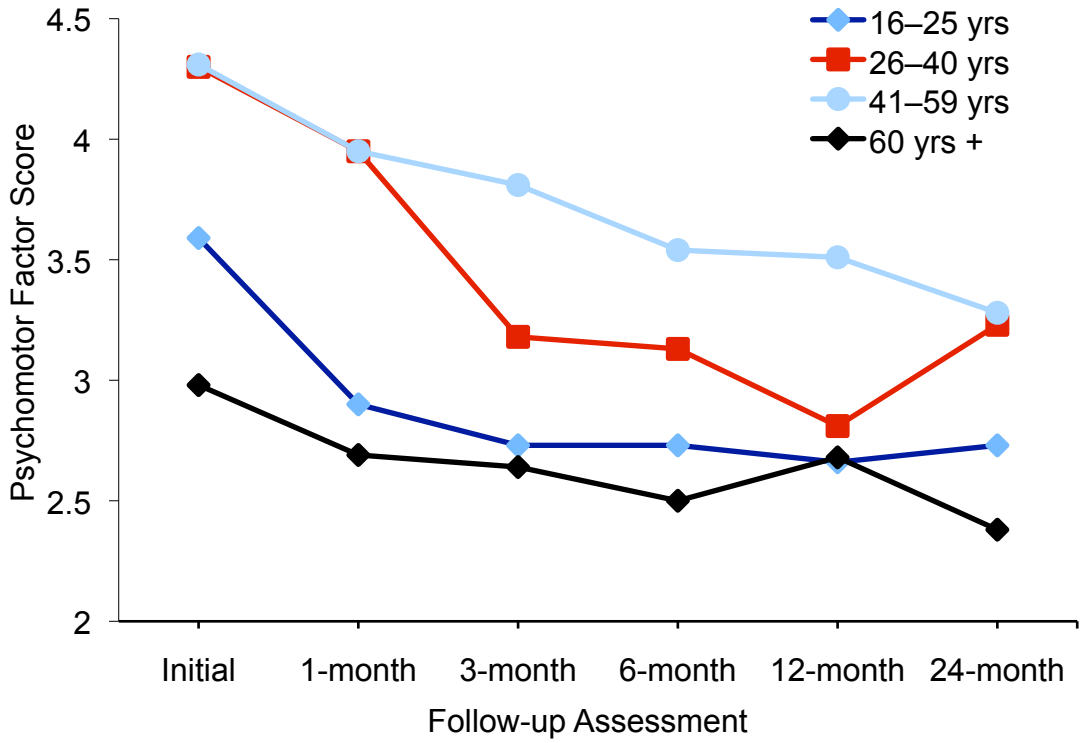

Figure 5.3. Mean psychomotor factor scores for age (cross-sectional sample).

Anxiety factor. Tests of between-subjects effects for age and gender on the HADS factors are shown in Table 5.3. On the Anxiety factor (see Figure 5.2), statistically significant main effects were found for gender at each follow-up ($p < .001$ at the initial, 3-month, and 6-month follow-ups; $p < .01$ at 1 month, 12 months, and 24 months), indicating females reported higher mean anxiety scores than males at each follow-up. $\eta^2_{partial}$ showed small effect sizes. Statistically significant main effects were found for age (Figure B3 in Appendix B) across the 12-month post-injury period ($p < .001$ at the initial, 1-month, 3-month, and 12-month follow-ups; $p < .01$ at 6 months), and when a more conservative alpha level was adopted ($p < .01$), there was a strong trend for a main effect of age at the 24-month follow-up ($p = .015$). For the main effect of age, $\eta^2_{partial}$ showed a medium effect size at 1 month and small effect sizes at the other follow-ups. On the Anxiety factor, the Age x Gender interaction was non-significant at each follow-up ($p > .05$).

Significant Tukey post-hoc tests for the HADS factors are displayed in Table 5.6 (for the full table of post-hoc tests for each of the HADS factors see 'Output – Study 1' in Appendix B on the CD). The 16–25 years age group showed significantly lower mean anxiety scores than the 41–59 years age group at the initial ($p < .05$), 1-month ($p < .01$), 3-month ($p < .05$), and 12-month ($p < .05$) follow-ups. The 16–25 years age group reported significantly lower mean anxiety scores than the 26–40 years age group at the initial and 1-month follow-ups ($p < .01$). The 41–59 years age group displayed significantly higher mean anxiety scores than the 60 years + group at all follow-ups ($p < .05$ at 24 months; $p < .01$ at 1 month and 6 months; $p < .001$ at the initial, 3-month, and 12-month follow-ups). The 26–40 years age group showed significantly higher mean anxiety scores than the 60 years + group at the initial ($p < .001$), 1-month ($p < .01$), 3-month ($p < .01$), 6-month ($p < .05$), and 24-month ($p < .01$) follow-ups.

Depression factor. On the Depression factor (Figure B3 in Appendix B; Table 5.4), a statistically significant main effect was found for gender at the initial and the 3-month follow-up ($p < .01$), and when a more conservative alpha level was adopted ($p < .01$), a strong trend at the 6-month follow-up ($p = .029$). These results indicated females reported higher mean depression scores than males at these follow-ups, with η^2_{partial} showing small effect sizes. No significant differences were found for gender at the other follow-ups ($p > .01$).

Significant main effects were found for age (Figure B4 in Appendix B; Table 5.4) at all follow-ups ($p < .001$ at the initial, 1-month, 3-month, 6-month, and 12-month follow-ups; $p < .01$ at 24 months). For the main effect of age, η^2_{partial} indicated a medium effect size at 1 month and small effect sizes at the other follow-ups. On the Depression factor, the Age x Gender interaction was non-significant at each follow-up ($p > .05$; Table 5.4).

Tukey post-hoc tests (Table 5.6) showed the 16–26 years age group reported significantly lower mean depression scores than the 26–40 years age group at the initial ($p <$

.001), 1-month ($p < .001$), and 24-month ($p < .01$) follow-ups. The 41–59 years age group displayed significantly higher mean depression scores than the 16–25 years age group at all follow-ups ($p < .05$ at the initial follow-up; $p < .01$ at 1 month and 24 months; $p < .001$ at 3 months, 6 months, and 12 months). The 26–40 years age group showed a significantly higher mean depression score than the 60 years + group at the initial follow-up ($p < .05$). The 41–59 years age group displayed a significantly higher mean depression score than the 60 years + age group at the 3-month follow-up ($p < .01$). The 41–59 years age group showed significantly higher mean depression scores than the 26–40 years age group at the 6-month ($p < .01$) and 12-month ($p < .05$) follow-ups, and a strong trend for a higher mean depression score than the 26–40 years age group at 3 months ($p = .062$).

Psychomotor factor. On the Psychomotor factor (Figure B2 in Appendix B; Table 5.5), a statistically significant main effect was found for gender at the 3-month follow-up ($p < .01$) and a strong trend for a main effect of age at the 1-month follow-up ($p = .072$). These results indicated females reported higher mean psychomotor scores than males at these follow-up assessments, with η^2_{partial} showing small effect sizes. No significant main effects for gender were found at the other follow-ups ($p > .05$). Statistically significant main effects were found for age (see Figure 5.3 and Table 5.5) at each follow-up over 12 months post-TBI ($p < .01$), and when a more conservative alpha level was adopted ($p < .01$) there was a trend for a main effect of age at 24 months ($p = .025$). For the main effect of age, η^2_{partial} indicated small effect sizes. On the Psychomotor factor, the Age x Gender interaction was non-significant at each follow-up ($p > .05$; Table 5.5).

Tukey post-hoc tests (Table 5.6) showed the 16–25 years age group reported significantly lower mean psychomotor scores than the 26–40 years age group at the initial ($p < .05$) and 1-month ($p < .01$) follow-ups. The 41–59 years age group displayed significantly higher mean psychomotor scores than the 16–25 years age group at the initial ($p < .05$), 1-

month ($p < .01$), 3-month ($p < .001$), 6-month ($p < .01$), and 12-month ($p < .01$) follow-ups. The 26–40 years age group showed significantly higher mean psychomotor scores than the 60 years + age group at the initial ($p < .01$) and 1-month ($p < .05$) follow-ups, and a strong trend for higher mean psychomotor scores than the 60 years + age group at the 24-month follow-up ($p = .076$). The 41–59 years age group displayed significantly higher mean psychomotor scores than the 60 years + age group at the initial ($p < .01$), 1-month ($p < .05$), 3-month ($p < .001$), 6-month ($p < .01$), and 24-month ($p < .05$) follow-ups, and a strong trend for significantly higher mean psychomotor scores than the 60 years + age group at 12 months ($p = .060$). The 41–59 years age group displayed a significantly higher mean psychomotor score than the 26–40 years age group at 3 months ($p < .05$), and a strong trend for a higher mean psychomotor score than the 26–40 years age group at 12 months ($p = .061$).

Table 5.3

Between-Subjects Effects for Age and Gender on the Anxiety Factor – Cross-Sectional Sample

Follow-up/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Age	3	484	7.38***	< .001	.04	.99
Gender	1	484	11.57***	.001	.02	.92
Age x Gender	3	484	1.15	.327	.01	.31
1-month						
Age	3	370	7.49***	< .001	.06	.99
Gender	1	370	7.37**	.007	.02	.77
Age x Gender	3	370	.98	.402	.01	.27
3-month						
Age	3	588	7.14***	< .001	.04	.98
Gender	1	588	25.27***	< .001	.04	1.00
Age x Gender	3	588	1.02	.382	.01	.28
6-month						
Age	3	587	4.00**	.008	.02	.84
Gender	1	587	15.84***	< .001	.03	.98
Age x Gender	3	587	1.99	.114	.01	.51
12-month						
Age	3	505	5.30***	.001	.03	.93
Gender	1	505	8.86**	.003	.02	.84
Age x Gender	3	505	.96	.410	.01	.26
24-month						
Age	3	472	3.51*	.015	.02	.78
Gender	1	472	7.54**	.006	.02	.78
Age x Gender	3	472	.93	.426	.01	.26

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 5.4

Between-Subjects Effects for Age and Gender on the Depression Factor – Cross-Sectional Sample

Follow-up/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Age	3	484	7.95***	< .001	.05	.99
Gender	1	484	8.08**	.005	.02	.81
Age x Gender	3	484	.57	.633	.00	.17
1-month						
Age	3	370	7.55***	< .001	.06	.99
Gender	1	370	2.00	.158	.01	.29
Age x Gender	3	370	.65	.583	.01	.19
3-month						
Age	3	588	7.63***	< .001	.04	.99
Gender	1	588	8.90**	.003	.02	.85
Age x Gender	3	588	.10	.960	.00	.07
6-month						
Age	3	587	7.95***	< .001	.04	.99
Gender	1	587	4.76*	.029	.01	.59
Age x Gender	3	587	.32	.813	.00	.11
12-month						
Age	3	505	5.81***	.001	.03	.95
Gender	1	505	1.54	.216	.00	.24
Age x Gender	3	505	.61	.606	.00	.18
24-month						
Age	3	472	4.28**	.005	.03	.86
Gender	1	472	1.21	.272	.00	.20
Age x Gender	3	472	.70	.551	.00	.20

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 5.5

Between-Subjects Effects for Age and Gender on the Psychomotor Factor – Cross-Sectional Sample

Follow-up/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Age	3	484	7.42***	< .001	.04	.99
Gender	1	484	3.26	.072	.01	.44
Age x Gender	3	484	1.34	.260	.01	.36
1-month						
Age	3	370	6.57***	< .001	.05	.97
Gender	1	370	.91	.342	.00	.16
Age x Gender	3	370	.97	.408	.01	.26
3-month						
Age	3	588	8.22***	< .001	.04	.99
Gender	1	588	8.14**	.004	.01	.81
Age x Gender	3	588	.76	.518	.00	.21
6-month						
Age	3	587	4.75**	.003	.02	.89
Gender	1	587	2.54	.112	.00	.36
Age x Gender	3	587	.40	.750	.00	.13
12-month						
Age	3	505	4.07**	.007	.02	.84
Gender	1	505	.04	.839	.00	.06
Age x Gender	3	505	.80	.495	.01	.22
24-month						
Age	3	472	3.13*	.025	.02	.78
Gender	1	472	1.08	.300	.00	.78
Age x Gender	3	472	.08	.972	.00	.26

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 5.6

Significant Tukey Post-Hoc Tests for Age on the HADS Factors – Cross-Sectional Sample

Follow-up	Comparison	Anxiety		Depression		Psychomotor	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial (<15days)	16–25 yrs & 26–40 yrs	.27	.007	.19	< .001	.25	.022
Initial (<15days)	16–25 yrs & 41–59 yrs	.29	.011	.20	.025	.27	.036
Initial (<15days)	26–40 yrs & 60 yrs +	.40	.001	.28	.046	.36	.002
Initial (<15days)	41–59 yrs & 60 yrs +	.41	.001	–	–	.38	.002
1-month	16–25 yrs & 26–40 yrs	.29	.005	.22	< .001	.30	.003
1-month	16–25 yrs & 41–59 yrs	.32	.003	.24	.002	.33	.009
1-month	26–40 yrs & 60 yrs +	.41	.007	–	–	.43	.019
1-month	41–59 yrs & 60 yrs +	.43	.004	–	–	.45	.027
3-month	16–25 yrs & 41–59 yrs	.25	.022	.17	< .001	.23	< .001
3-month	26–40 yrs & 41–59 yrs	–	–	–	–	.24	.045
3-month	26–40 yrs & 60 yrs +	.33	.010	.18	.062	–	–
3-month	41–59 yrs & 60 yrs +	.32	< .001	.22	.007	.30	< .001
6-month	16–25 yrs & 41–59 yrs	–	–	.18	< .001	.24	.005
6-month	26–40 yrs & 60 yrs +	.34	.047	.19	.009	–	–
6-month	41–59 yrs & 60 yrs +	.33	.007	–	–	.32	.007
12-month	16–25 yrs & 41–59 yrs	.27	.026	.20	< .001	.26	.007
12-month	26–40 yrs & 41–59 yrs	–	–	.21	.017	.28	.061
12-month	41–59 yrs & 60 yrs +	.35	.001	–	–	.33	.060
24-month	16–25 yrs & 26–40 yrs	–	–	.22	.009	–	–
24-month	16–25 yrs & 41–59 yrs	–	–	.20	.010	–	–
24-month	26–40 yrs & 60 yrs +	.37	.010	–	–	.36	.076
24-month	41–59 yrs & 60 yrs +	.35	.023	–	–	.34	.041

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

Longitudinal sample. Two-way mixed between-within subjects ANOVAs were conducted to assess the impact of age and gender on TBI participants' HADS scores across six time-periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month

follow-ups). The analyses were conducted on the HADS data of 101 participants who came to every follow-up assessment. The groups consisted of: females (n = 42), males (n = 59), 16–25 years (n = 32), 26–40 years (n = 21), 41–59 years (n = 31), and 60 years + (n = 17). Table 5.7 (gender) and Table 5.8 (age) display the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted over time for gender (See Appendix B – Figures B5, B6, and B7) and age (See Appendix B – Figures B8, B9, and B10).

Table 5.7

Descriptive Statistics for Gender on the HADS factors – Longitudinal Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Males	2.20	1.93	1.91	1.55	1.64	1.98
	(1.92)	(1.96)	(1.90)	(1.91)	(2.03)	(1.97)
Females	2.68	2.29	2.06	2.04	2.00	2.07
	(2.44)	(2.20)	(2.12)	(2.00)	(2.03)	(1.90)
Depression						
Males	1.57	1.32	1.07	.86	1.03	.98
	(1.87)	(1.83)	(1.48)	(1.36)	(1.56)	(1.81)
Females	1.62	1.14	.97	1.09	.82	.93
	(1.80)	(1.16)	(1.35)	(1.35)	(1.13)	(1.23)
Psychomotor						
Males	3.47	3.18	2.82	2.48	2.57	2.51
	(2.21)	(2.71)	(2.37)	(2.11)	(2.40)	(2.25)
Females	3.45	2.72	2.49	2.40	2.16	2.27
	(1.94)	(1.99)	(1.70)	(1.57)	(1.73)	(1.66)

Note. Mean values are displayed with standard deviations presented in parentheses.

Table 5.8

Descriptive Statistics for Age on the HADS factors – Longitudinal Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
16–25 yrs	2.40	2.26	2.41	1.84	1.68	2.08
	(1.96)	(1.95)	(1.80)	(1.67)	(2.02)	(1.93)
26–40 yrs	2.37	1.96	1.24	1.29	1.93	1.63
	(2.39)	(2.06)	(1.73)	(1.84)	(2.48)	(1.67)
41–59 yrs	2.85	2.35	2.40	2.18	2.24	2.37
	(2.37)	(2.36)	(2.34)	(2.51)	(2.00)	(2.14)
60 yrs +	1.62	1.39	1.26	1.37	1.02	1.73
	(1.70)	(1.64)	(1.53)	(1.24)	(1.24)	(1.85)
Depression						
16–25 yrs	1.29	.93	1.12	.60	.72	.80
	(1.50)	(1.49)	(1.44)	(1.09)	(1.03)	(1.55)
26–40 yrs	1.53	1.25	.69	.38	.88	.84
	(1.83)	(1.77)	(1.38)	(.73)	(1.76)	(1.89)
41–59 yrs	1.80	1.34	.92	1.11	.95	.99
	(1.97)	(1.58)	(1.46)	(1.56)	(1.45)	(1.62)
60 yrs +	1.85	1.66	1.49	2.04	1.39	1.36
	(2.18)	(1.53)	(1.36)	(1.41)	(1.42)	(1.23)
Psychomotor						
16–25 yrs	3.32	2.54	3.08	2.18	2.25	2.34
	(1.92)	(2.15)	(2.05)	(1.67)	(2.00)	(2.10)
26–40 yrs	3.73	3.15	2.02	2.18	2.35	2.45
	(2.42)	(2.58)	(2.03)	(2.09)	(2.72)	(2.26)
41–59 yrs	3.70	3.32	2.74	2.88	2.61	2.54
	(1.89)	(2.50)	(2.23)	(2.04)	(2.17)	(2.16)
60 yrs +	2.95	3.04	2.65	2.50	2.36	2.24
	(2.40)	(2.71)	(2.09)	(1.78)	(1.68)	(1.34)

Note. Mean values are displayed with standard deviations presented in parentheses.

Anxiety factor. Table 5.9 shows the tests of within-subjects effects for age and gender on each of the HADS factors. There was a significant main effect for time since TBI on the Anxiety factor, $F(4, 364) = 4.38$, $p = .002$, $\eta^2_{partial} = .05$, indicating a small effect size for TBI participants to show a significant reduction in their anxiety scores over time. No significant interactions were found on the Anxiety factor for Time x Gender, $F(4, 364) = .46$, $p = .759$, $\eta^2_{partial} = .01$; Time x Age, $F(12, 364) = .93$, $p = .520$, $\eta^2_{partial} = .03$; or Time x Age x Gender, $F(12, 364) = 1.04$, $p = .415$, $\eta^2_{partial} = .03$.

Significant Bonferroni post-hoc comparisons for time are displayed in Table B3 in Appendix B (for the full table of comparisons for each of the HADS factors see 'Output – Study 1' in Appendix B on the CD). Significant differences in mean anxiety scores ($p < .05$) were found between the initial follow-up and: the 3-month, 6-month, and 12-month follow-ups.

Tests of between-subjects effects for age and gender on each of the HADS factors are shown in Table 5.10. There were no significant between-subjects main effects on the Anxiety factor for age, $F(3, 93) = 1.79$, $p = .154$, $\eta^2_{partial} = .06$, or gender, $F(1, 93) = .27$, $p = .605$, $\eta^2_{partial} = .00$, indicating no difference between the mean scores of the groups. However, when adopting a more stringent alpha level ($p < .01$), there was a trend for a between-subjects Age x Gender interaction on the Anxiety factor, $F(3, 93) = 2.91$, $p = .039$, $\eta^2_{partial} = .09$, with a medium effect size. The results indicate that females in the 41–59 years group scored the highest on the Anxiety factor (see Figure B11 in Appendix B).

Depression factor. There was a significant main effect for time since TBI on the Depression factor, $F(3, 322) = 5.35$, $p = .001$, $\eta^2_{partial} = .05$, indicating a small effect size for TBI participants to show a significant reduction in their depression scores over time. No significant interactions were found for Time x Gender, $F(3, 322) = .53$, $p = .685$, $\eta^2_{partial} =$

.01; Time x Age, $F(10, 322) = .91$, $p = .530$, $\eta^2_{partial} = .03$; or Time x Age x Gender, $F(10, 322) = 1.57$, $p = .111$, $\eta^2_{partial} = .05$.

Significant differences in mean depression scores were found between the initial follow-up and: the 3-month ($p = .014$), 6-month ($p = .018$), and 12-month ($p = .014$) follow-ups (Table B3 – Appendix B). There was a trend for differences in mean depression scores between the initial and 24-month follow-up ($p = .070$). There were no significant between-subjects main effects for gender, $F(1, 93) = .86$, $p = .357$, $\eta^2_{partial} = .01$, or age, $F(3, 93) = 1.95$, $p = .128$, $\eta^2_{partial} = .06$, indicating no difference between the mean depression scores of the groups (Table 5.10). The between-subjects Age x Gender interaction on the Depression factor was non-significant, $F(3, 93) = .84$, $p = .476$, $\eta^2_{partial} = .03$ (Table 5.10).

Psychomotor factor. There was a highly significant main effect for time since TBI on the Psychomotor factor, $F(4, 404) = 9.87$, $p < .001$, $\eta^2_{partial} = .10$. This indicated a medium effect size for TBI participants to show a significant reduction in their psychomotor scores over time. No significant interactions were found for Time x Gender, $F(4, 404) = .79$, $p = .539$, $\eta^2_{partial} = .01$; Time x Age, $F(13, 404) = 1.04$, $p = .414$, $\eta^2_{partial} = .03$; or Time x Age x Gender, $F(13, 404) = 1.46$, $p = .130$, $\eta^2_{partial} = .05$.

Significant differences in mean psychomotor scores ($p < .01$) were found between the initial follow-up and: the 3-month, 6-month, 12-month, and 24-month follow-ups (see Table B3 – Appendix B). Significant differences in mean psychomotor scores were also found between the 1-month follow-up and: the 6-month ($p < .05$) and 12-month ($p < .01$) follow-ups. A trend for a difference in mean psychomotor scores ($p = .058$) was found between the 1-month and 24-month follow-ups.

There were no between-subjects main effects for gender, $F(1, 93) = 1.65$, $p = .203$, $\eta^2_{partial} = .02$, or age, $F(3, 93) = .25$, $p = .858$, $\eta^2_{partial} = .01$, indicating no difference between the mean psychomotor scores of the groups (Table 5.10). The between-subjects Age x Gender

interaction was non-significant on the Psychomotor factor, $F(3, 93) = 1.88$, $p = .138$, $\eta^2_{partial} = .06$ (Table 5.10).

Table 5.9

Tests of Within-Subjects for Age and Gender on the HADS factors

HADS Factor/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI	4	364	4.38**	.002	.05	.99
Time x Age	12	364	.93	.520	.03	.54
Time x Gender	4	364	.46	.759	.01	.16
Time x Age x Gender	12	364	1.04	.415	.03	.60
Depression						
Time since TBI	3	322	5.35***	.001	.05	.96
Time x Age	10	322	.91	.530	.03	.49
Time x Gender	3	322	.53	.685	.01	.17
Time x Age x Gender	10	322	1.57	.111	.05	.78
Psychomotor						
Time since TBI	4	404	9.87***	< .001	.10	1.00
Time x Age	13	404	1.04	.414	.03	.63
Time x Gender	4	404	.79	.539	.01	.27
Time x Age x Gender	13	404	1.46	.130	.05	.82

Note. Greenhouse-Geisser results are reported.
**$p < .01$. ***$p < .001$.

Table 5.10

Tests of Between-Subjects Effects for Age and Gender on the HADS factors – Longitudinal Sample

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Age	3	93	1.79	.154	.06	.45
Gender	1	93	.27	.605	.00	.08
Age x Gender	3	93	2.91*	.039	.09	.68
Depression						
Age	3	93	1.95	.128	.06	.49
Gender	1	93	.86	.357	.01	.15
Age x Gender	3	93	.84	.476	.03	.23
Psychomotor						
Age	3	93	.25	.858	.01	.09
Gender	1	93	1.65	.203	.02	.25
Age x Gender	3	93	1.88	.138	.06	.47

Note. $^*p < .05$.

5.3.3 Estimated Pre-morbid IQ

Cross-sectional sample. One-way between subjects ANOVAs were conducted to assess the impact of participants' estimated pre-morbid IQ on HADS scores at each follow-up (Table 5.12). Participants were categorized according to four groups, based upon their NART-R scores: below average (NART score = 73–89), lower average (NART score = 90–99), higher average (NART score = 100–109), and above average (NART score = 110 +; Wechsler, 2008). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 273 to 415 participants: below average (*n* = 48–72), lower average (*n* = 86–99), higher average (*n* = 97–161), and above average (*n* = 56–88; see Figure 5.1). Mean HADS factor scores and standard deviations are shown in Table 5.11. The mean scores are plotted for the Anxiety factor (Figure 5.4), Depression factor (Figure 5.5), and the Psychomotor factor (Figure B12 in Appendix B). Table 5.12 shows the one-way ANOVAs for the four estimated pre-morbid IQ groups on the HADS.

Table 5.11

Descriptive Statistics for Estimated Pre-morbid IQ (Four Groups) on the HADS Factors – Cross-Sectional Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Below Average IQ	4.34	3.81	3.20	3.06	2.75	2.63
	(2.67)	(2.63)	(2.77)	(2.93)	(2.75)	(2.61)
Lower Average IQ	3.06	2.89	2.98	2.51	2.39	2.90
	(2.47)	(2.19)	(2.63)	(2.33)	(2.27)	(2.43)
Higher Average IQ	3.18	2.60	2.72	2.48	2.59	2.69
	(2.40)	(2.31)	(2.36)	(2.28)	(2.35)	(2.43)
Above Average IQ	2.58	1.84	1.91	1.57	1.69	1.97
	(2.38)	(1.69)	(2.24)	(2.02)	(2.21)	(2.38)
Depression						
Below Average IQ	2.06	2.19	1.89	1.64	1.72	1.62
	(1.93)	(1.86)	(1.93)	(1.92)	(1.95)	(2.13)
Lower Average IQ	1.46	1.38	1.27	1.07	1.14	1.45
	(1.63)	(1.80)	(1.61)	(1.39)	(1.48)	(1.82)
Higher Average IQ	1.43	1.17	1.31	1.26	1.33	1.12
	(1.55)	(1.55)	(1.60)	(1.51)	(1.69)	(1.56)
Above Average IQ	1.84	1.33	1.24	1.14	1.06	1.43
	(2.08)	(1.53)	(1.64)	(1.72)	(1.66)	(1.94)
Psychomotor						
Below Average IQ	4.71	4.42	3.42	3.25	3.22	2.98
	(2.33)	(2.44)	(2.43)	(2.52)	(2.70)	(2.95)
Lower Average IQ	3.53	3.44	3.28	2.99	3.01	3.30
	(2.23)	(2.43)	(2.20)	(2.08)	(2.00)	(2.29)
Higher Average IQ	3.77	3.04	3.13	3.08	3.05	2.85
	(2.04)	(2.30)	(2.23)	(2.06)	(2.17)	(2.12)
Above Average IQ	3.87	2.90	2.67	2.49	2.21	2.66
	(2.42)	(2.22)	(2.24)	(2.21)	(2.04)	(2.44)

Note. Mean values are displayed with standard deviations presented in parentheses.

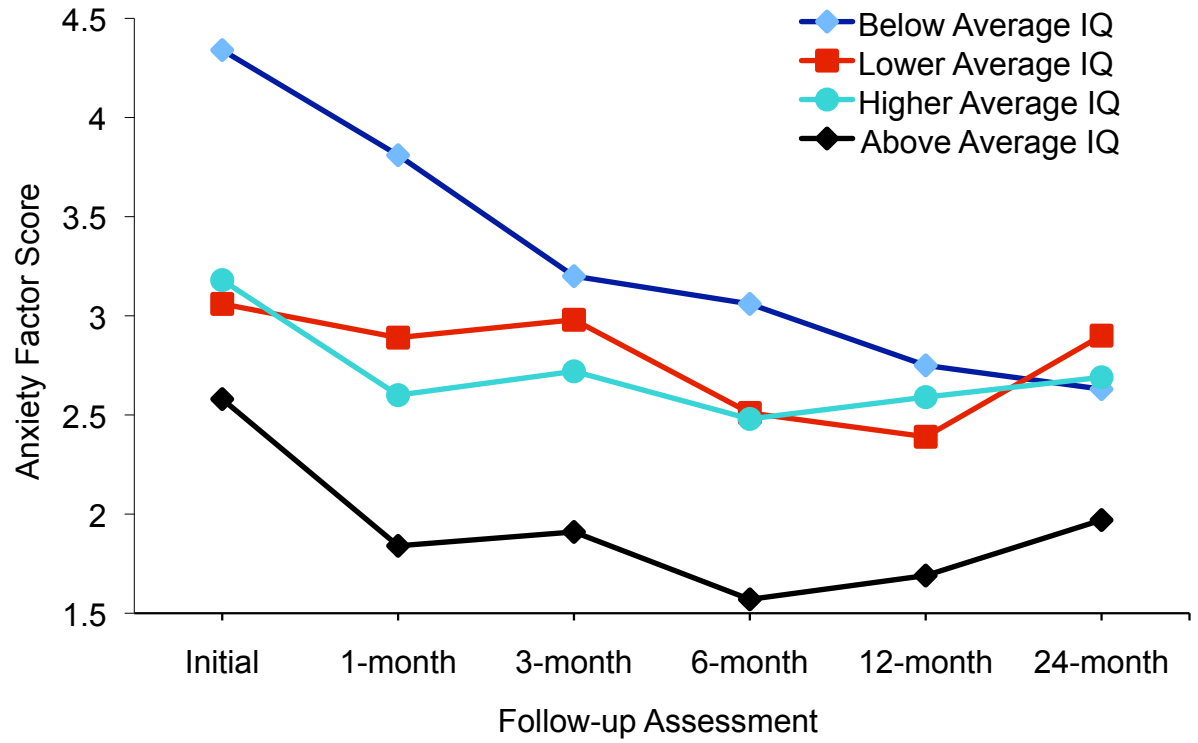

Figure 5.4. Mean anxiety factor scores for est. pre-morbid IQ (cross-sectional sample).

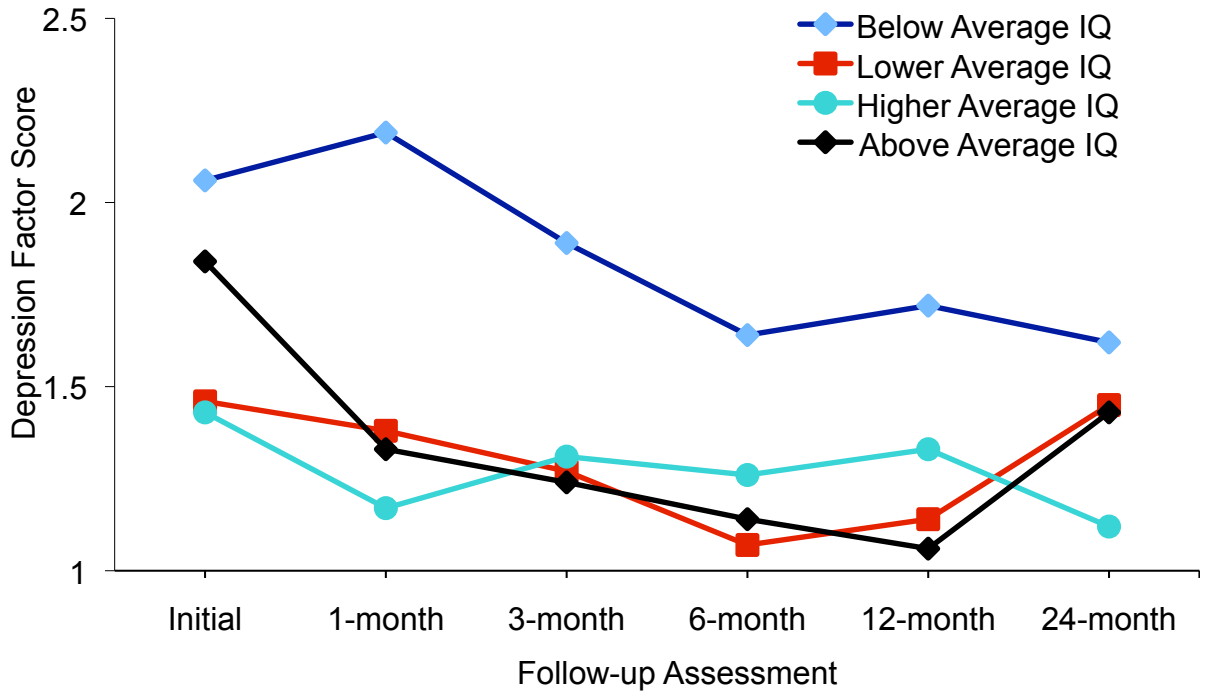

Figure 5.5. Mean depression factor scores for est. pre-morbid IQ (cross-sectional sample).

Anxiety factor. On the Anxiety factor (see Figure 5.4; Table 5.12), significant differences in mean scores were found between the groups at the initial, 1-month, 3-month, and 6-month follow-ups ($p < .01$). A trend was found for a difference between the mean anxiety scores of the groups at the 12-month ($p = .033$) and 24-month ($p = .077$) follow-ups. $\eta^2_{partial}$ indicated a medium effect for a significant difference in mean anxiety scores at 1-month, and small effect sizes at the other follow-ups.

Table 5.13 shows the Tukey post-hoc tests that were significant or indicated a trend for differences between follow-ups (for the full table of post-hoc tests for each of the HADS factors see 'Output – Study 1' in Appendix B on the CD). The below average IQ group showed a significantly higher mean anxiety score than the higher average IQ group at the initial ($p < .05$) and 1-month ($p < .01$) follow-ups. The below average IQ group displayed significantly higher mean anxiety scores than the above average IQ group at the initial ($p < .001$), 1-month ($p < .001$), 3-month ($p < .01$), and 6-month ($p < .001$) follow-ups, and there was a trend for the below average IQ group to have a higher mean anxiety score than the above average IQ group at the 12-month follow-up ($p = .052$). The below average IQ group showed a significantly higher mean anxiety score than the lower average IQ group at the initial follow-up ($p < .01$).

The lower average IQ group displayed significantly higher mean anxiety scores than the above average IQ group at the 1-month, 3-month, and 6-month follow-ups ($p < .05$). There was a trend for the lower average IQ group to have higher mean anxiety scores than the above average IQ group at the 24-month follow-up ($p = .072$). The higher average IQ group showed significantly higher anxiety scores than the above average IQ group at 6 months and 12 months ($p < .05$), with a trend for the higher average IQ group to show higher anxiety scores than the above average IQ group at 3 months ($p = .074$).

Depression factor. On the Depression factor (see Figure 5.5; Table 5.12), a strong trend for differences in mean scores was found at the initial follow-up ($p = .056$). Significant differences in mean depression scores were found between the groups at the 1- and 3-month follow-ups ($p < .05$). $\eta^2_{partial}$ indicated small effect sizes.

Tukey post-hoc tests (Table 5.13) showed the below average IQ group reported a significantly higher mean depression score than the higher average IQ group at 1 month ($p < .01$). There was a trend for the below average IQ group to display higher mean depression scores than the higher average IQ group at the initial ($p = .085$) and 3-month ($p = .073$) follow-ups. The below average IQ group displayed significantly higher mean depression scores than the higher average IQ group at 1 month ($p = .046$), and a strong trend for a higher mean depression score than the higher average IQ group at 3 months ($p = .078$). The below average IQ group showed a significantly higher mean depression score than above average IQ group at 1 month ($p < .05$). There was a trend for the below average IQ group to show a higher mean depression score than above average IQ group at 3 months ($p = .072$).

Psychomotor factor. On the Psychomotor factor (Figure B12 in Appendix B; Table 5.12), significant differences in mean scores ($p < .05$) were found at the initial and 1-month follow-up. A trend for differences in mean scores was found at the 12-month follow-up ($p = .026$). For the Psychomotor factor, $\eta^2_{partial}$ indicated small effect sizes.

Tukey post-hoc tests (Table 5.13) showed the below average IQ group reported a significantly higher mean psychomotor score than the lower average IQ group at the initial follow-up ($p < .01$) and a significantly higher mean psychomotor score than the higher average IQ group at the initial ($p < .05$) and 1-month ($p < .01$) follow-ups. The below average IQ group showed significantly higher mean psychomotor scores than the above average IQ group at the 1-month ($p < .01$) and 12-month follow-ups ($p = .046$). At the 12-month follow-up, the above average IQ group showed a significantly lower mean psychomotor score than

the higher average IQ group ($p < .05$), and a weak trend for a lower mean psychomotor score ($p = .099$).

Table 5.12

One-Way ANOVAs for Estimated Pre-morbid IQ (Four Groups) on the HADS – Cross-Sectional Sample

Follow-up/ HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Anxiety	3	358	6.30***	< .001	.05	.97
Depression	3	358	2.54	.056	.02	.61
Psychomotor	3	358	3.95**	.009	.03	1.00
1-month						
Anxiety	3	217	7.29***	< .001	.07	.98
Depression	3	269	4.38**	.005	.05	.90
Psychomotor	3	269	4.89**	.003	.05	.90
3-month						
Anxiety	3	328	4.20**	.006	.03	.86
Depression	3	405	2.67*	.047	.02	.67
Psychomotor	3	405	1.78	.151	.01	.37
6-month						
Anxiety	3	290	5.16***	.002	.04	.95
Depression	3	293	1.84	.140	.01	.37
Psychomotor	3	411	1.84	.139	.01	.37
12-month						
Anxiety	3	262	2.85*	.038	.02	.33
Depression	3	259	1.96	.121	.02	.33
Psychomotor	3	242	2.95*	.033	.03	.81
24-month						
Anxiety	3	339	2.30	.077	.02	.58
Depression	3	223	1.12	.341	.01	.31
Psychomotor	3	207	.92	.432	.01	.31

Note. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 5.13

Significant/Trend Tukey Post-hoc Tests for Estimated Pre-morbid IQ on the HADS Factors – Cross-Sectional Sample

Follow-up	Comparison	Anxiety		Depression		Psychomotor	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial (<15 days)	Below Av & Lower Av	.40	.007	–	–	.36	.005
Initial (<15 days)	Below Av & Higher Av	.37	.011	.27	.085	.34	.029
Initial (<15 days)	Below Av & Above Av	.42	< .001	–	–	–	–
1-month	Below Av & Lower Av	–	–	.31	.046	–	–
1-month	Below Av & Higher Av	.38	.010	.29	.003	.40	.004
1-month	Below Av & Above Av	.43	< .001	.32	.041	.45	.005
1-month	Lower Av & Above Av	.40	.047	–	–	–	–
3-month	Below Av & Lower Av	–	–	.26	.078	–	–
3-month	Below Av & Higher Av	–	–	.24	.073	–	–
3-month	Below Av & Above Av	.39	.007	.27	.072	–	–
3-month	Lower Av & Above Av	.36	.019	–	–	–	–
3-month	Higher Av & Above Av	.33	.074	–	–	–	–
6-month	Below Av IQ & Above Av	.38	.001	–	–	–	–
6-month	Lower Av & Above Av	.35	.040	–	–	–	–
6-month	Higher Av & Above Av	.32	.023	–	–	–	–
12-month	Below Av & Above Av	.41	.052	–	–	.39	.046
12-month	Lower Av & Above Av	–	–	–	–	.35	.099
12-month	Higher Av & Above Av	.34	.042	–	–	.31	.042
24-month	Lower Av & Above Av	.38	.072	–	–	–	–

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' estimated pre-morbid IQ on HADS scores across six time periods post-trauma (the initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 79 participants who completed the NART-R at the initial follow-up, and the HADS at every follow-up assessment. Following a

frequency analysis, to keep adequate cell sizes the sample was split into two groups according to the midpoint of the IQ distribution (Weschler, 2008): the NART < 100 group (*n* = 27) and the NART > = 100 group (*n* = 52). Mean HADS factor scores and standard deviations are shown in Table 5.14. The mean scores were plotted over time for the Anxiety factor (Figure B13 in Appendix B), Depression factor (Figure B14 in Appendix B), and Psychomotor factor (Figure 5.6).

Table 5.14

Descriptive Statistics for Estimated Pre-morbid IQ on the HADS Factors – Longitudinal Sample

HADS Factor/Group	Initial (< 15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
NART < 100	2.79	2.21	2.69	2.05	2.06	2.50
	(2.28)	(2.12)	(2.14)	(2.24)	(2.06)	(2.00)
NART > = 100	2.13	1.81	1.65	1.60	1.63	1.84
	(1.99)	(1.96)	(1.86)	(1.91)	(1.92)	(1.95)
Depression						
NART < 100	1.69	1.08	1.49	.88	.92	1.13
	(1.82)	(1.80)	(1.81)	(1.25)	(1.25)	(2.02)
NART > = 100	1.70	1.46	1.06	1.15	1.07	.98
	(1.82)	(1.62)	(1.36)	(1.51)	(1.53)	(1.48)
Psychomotor						
NART < 100	3.53	3.03	3.25	2.71	2.94	3.13
	(1.93)	(2.50)	(2.07)	(2.12)	(2.31)	(2.36)
NART > = 100	3.54	3.03	2.55	2.58	2.38	2.09
	(2.30)	(2.67)	(2.17)	(1.92)	(2.14)	(1.79)

Note. Mean values are displayed with standard deviations presented in parentheses.

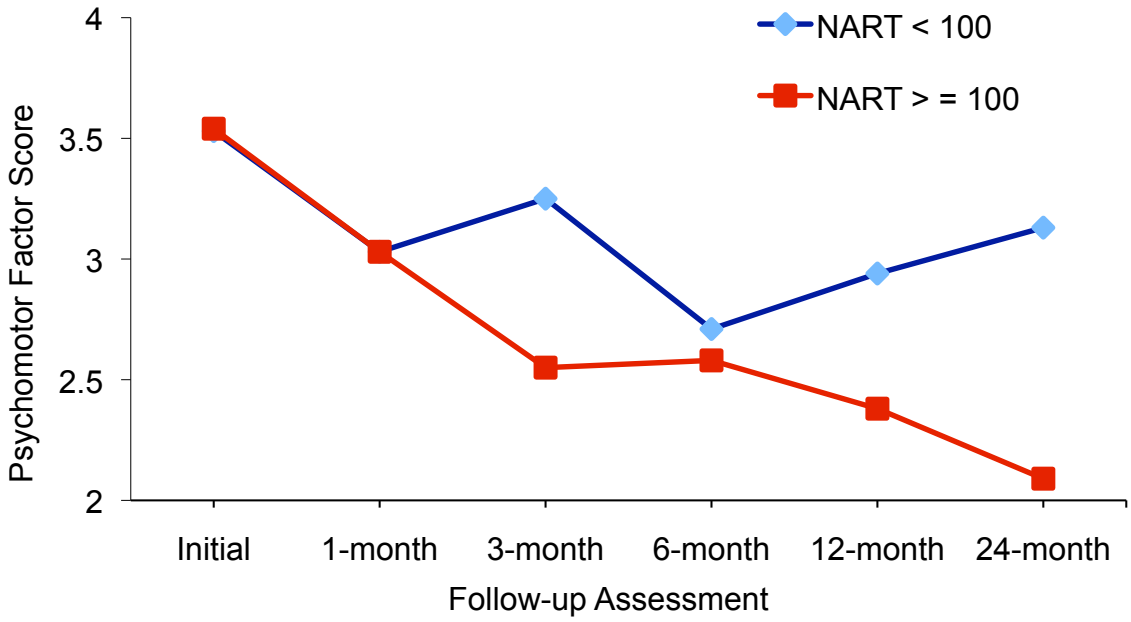

Figure 5.6. Mean psychomotor factor scores over time for est. pre-morbid IQ (longitudinal sample).

Table 5.15 shows the within-subjects effects for estimated pre-morbid IQ on the HADS factors. There was a significant main effect for time since TBI on the Anxiety factor, $F(4, 303) = 3.52$, $p = .008$, $\eta^2_{partial} = .04$; Depression factor, $F(4, 286) = 4.37$, $p = .002$, $\eta^2_{partial} = .05$; and Psychomotor factor, $F(4, 335) = 5.49$, $p < .001$, $\eta^2_{partial} = .07$. These results indicate a significant reduction in participants' mean HADS scores over time. The effect size for time was small for the Anxiety and Depression factors, and medium for the Psychomotor factor.

Bonferroni post-hoc comparisons for time, for each of the HADS factors are displayed in 'Output – Study 1' (Appendix B on the CD). Table B4 (Appendix B) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. A significant difference in mean anxiety scores was found between the initial and 6-month follow-up ($p = .018$). Significant differences in mean depression scores were found between the initial follow-up and: the 6-month ($p = .027$), and 12-month ($p = .046$) follow-ups. There were significant differences in mean psychomotor scores between the initial follow-up and: the 6-month ($p = .002$), 12-month ($p = .011$), and 24-month ($p = .003$) follow-ups.

Tests of between-subjects effects for estimated pre-morbid IQ on the HADS factors are displayed in Table 5.15. The main effect comparing the two NART groups was not significant for the Anxiety factor, $F(1, 77) = 2.14$, $p = .148$, $\eta^2_{partial} = .03$; Depression factor, $F(1, 77) = .02$, $p = .903$, $\eta^2_{partial} = .00$; and the Psychomotor factor, $F(1, 77) = .82$, $p = .367$, $\eta^2_{partial} = .01$. This indicates no difference between the mean HADS scores of the groups.

There were no significant Time x NART interactions for the Anxiety factor, $F(4, 303) = .88$, $p = .470$, $\eta^2_{partial} = .01$, or the Depression factor $F(4, 286) = 1.38$, $p = .244$, $\eta^2_{partial} = .02$. However, a trend was found for a Time x NART interaction on the Psychomotor factor, $F(4, 335) = 2.05$, $p = .071$, $\eta^2_{partial} = .03$; with a small effect size. This indicated that from 1 month to 3 months, the NART > = 100 group showed a decreased mean psychomotor score, while there was little change in the mean psychomotor score of the NART < 100 group across these two follow-ups. Additionally, from 3 months to 6 months, the NART < 100 group showed a decreased mean psychomotor score, while there was little change in the mean psychomotor score of the NART > = 100 group (see Figure 5.6).

Table 5.15

Tests of Within-Subjects and Between-Subjects Effects for Estimated Pre-morbid IQ on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI [a]	4	303	3.52**	.008	.04	.86
NART	1	77	2.14	.148	.03	.30
Time x NART [a]	4	303	.88	.470	.01	.28
Depression						
Time since TBI [a]	4	286	4.37**	.002	.05	.92
NART	1	77	.02	.903	.00	.05
Time x NART [a]	4	286	1.38	.244	.02	.41
Psychomotor						
Time since TBI [a]	4	335	5.49***	< .001	.07	.98
NART	1	77	.82	.367	.01	.15
Time x NART [a]	4	335	2.05	.071	.03	.68

Note. [a]Greenhouse-Geisser results are reported.
**$p < .01$. ***$p < .001$.

5.3.4 Relationship Status

Cross-sectional sample. Independent samples *t*-tests were conducted at each follow-up to compare participants' HADS scores based on their relationship status (Table 5.17). Two groups (in a relationship/not in a relationship) were included in the analyses. Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 338 to 521 participants: in a relationship (n = 172–266) and not in a relationship (n = 166–255; see Figure 5.1). Table 5.16 displays the mean HADS factor scores and standard deviations from these analyses.

Table 5.16

Descriptive Statistics for Relationship Status on the HADS Factors – Cross-Sectional Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
In a relationship	3.11	2.74	2.39	2.28	2.31	2.28
	(2.48)	(2.30)	(2.35)	(2.32)	(2.42)	(2.21)
Not in a relationship	3.20	2.66	2.77	2.49	2.50	2.79
	(2.55)	(2.31)	(2.52)	(2.45)	(2.51)	(2.58)
Depression						
In a relationship	1.63	1.48	1.18	1.27	1.32	1.20
	(1.79)	(1.80)	(1.54)	(1.61)	(1.73)	(1.65)
Not in a relationship	1.59	1.41	1.43	1.32	1.37	1.44
	(1.69)	(1.70)	(1.82)	(1.78)	(1.82)	(1.95)
Psychomotor						
In a relationship	3.80	3.36	2.90	2.92	2.90	2.76
	(2.27)	(2.49)	(2.16)	(2.30)	(2.33)	(2.14)
Not in a relationship	3.94	3.36	3.34	3.07	2.86	3.16
	(2.32)	(2.34)	(2.27)	(2.31)	(2.24)	(2.50)

Note. Mean values are displayed with standard deviations presented in parentheses.

Anxiety factor. On the Anxiety factor (Table 5.17), the not in a relationship group showed a significantly higher mean HADS score than the in a relationship group at the 24-month follow-up ($p < .05$). A trend was found at the 3-month follow-up ($p = .078$) for the not in a relationship group to display a higher mean anxiety score than the in a relationship group. No significant differences in mean anxiety scores were found at the other follow-ups ($p > .05$). Cohen's *d* indicated small effect sizes.

Depression factor. On the Depression factor (Table 5.17), a trend was found at the 3-month follow-up ($p = .090$) for the not in a relationship group to have a higher mean score than the in a relationship group. No significant differences in mean depression scores were found at the other follow-ups ($p > .05$). Cohen's *d* indicated small effect sizes.

Psychomotor factor. On the Psychomotor factor (Table 5.17), the not in a relationship group showed a significantly higher mean score than the in a relationship group at the 3-month follow-up ($p < .05$). A trend was found at the 24-month follow-up ($p = .080$) for the not in a relationship group to display a higher mean psychomotor score than the in a relationship group. No significant differences in mean psychomotor scores were found at the other follow-ups ($p > .05$). Cohen's *d* indicated small effect sizes.

Table 5.17

Independent Samples t-Tests for Relationship Status – Cross-Sectional Sample

Follow-up/ HADS Factor	*t*	*df*	*p*	Cohen's *d*	Power	Mean Difference	95% CI LL	95% CI UL
Initial (<15 days)								
Anxiety	-.37	465	.711	-.03	.06	-.09	-.54	.37
Depression	.29	465	.775	.03	.06	.05	-.27	.36
Psychomotor	-.64	465	.520	-.06	.07	-.14	-.55	.28
1-month								
Anxiety	.33	336	.743	.04	.07	.08	-.42	.58
Depression	.37	336	.715	.04	.07	.07	-.30	.44
Psychomotor	-.02	336	.982	-.00	.05	-.01	-.52	.51
3-month								
Anxiety	-1.76	519	.078	-.15	.39	-.38	-.79	.04
Depression	-1.70	497	.090	-.15	.39	-.25	-.54	.04
Psychomotor	-2.26*	519	.025	-.20	.62	-.44	-.82	-.06
6-month								
Anxiety	-.94	499	.346	-.08	.15	-.20	-.62	.22
Depression	-.35	499	.730	-.03	.06	-.05	-.35	.25
Psychomotor	-.73	499	.467	-.07	.12	-.15	-.55	.26
12-month								
Anxiety	-.82	458	.414	-.08	.14	-.19	-.64	.26
Depression	-.30	458	.768	-.03	.06	-.05	-.37	.28
Psychomotor	.16	458	.872	.01	.05	.03	-.39	.45
24-month								
Anxiety	-2.15*	403	.032	-.21	.55	-.51	-1.69	.07
Depression	-1.31	347	.192	-.14	.29	-.24	-2.14	-.41
Psychomotor	-1.75	403	.080	-.17	.40	-.41	-2.08	-.43

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' initial relationship status on HADS scores across six time periods post-trauma (initial follow-up, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 95 participants who came to every follow-up assessment and completed the HADS. The analyses consisted of two groups: the in a relationship group (n = 55) and the not in a relationship group (n = 40). Mean HADS factor scores and standard deviations are shown in Table 5.18.

Table 5.18

Descriptive Statistics for Relationship Status on the HADS factors - Longitudinal Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
In a relationship	2.33	2.11	1.85	1.71	1.78	1.94
	(2.04)	(2.04)	(2.05)	(1.86)	(1.93)	(1.97)
Not in a relationship	2.30	1.83	1.98	1.61	1.62	1.97
	(2.11)	(1.87)	(1.77)	(1.78)	(1.72)	(1.79)
Depression						
In a relationship	1.58	1.42	.92	.93	.87	.89
	(1.81)	(1.66)	(1.36)	(1.28)	(1.31)	(1.52)
Not in a relationship	1.55	.95	1.11	.91	.88	.88
	(1.87)	(1.31)	(1.51)	(1.33)	(1.39)	(1.47)
Psychomotor						
In a relationship	3.35	3.08	2.34	2.47	2.24	2.30
	(2.14)	(2.55)	(2.10)	(2.13)	(2.09)	(1.93)
Not in a relationship	3.42	2.71	2.94	2.36	2.24	2.40
	(2.00)	(2.13)	(1.99)	(1.53)	(1.82)	(1.96)

Note. Mean values are displayed with standard deviations presented in parentheses

Table 5.19 shows the test of within-subjects for relationship status on the HADS factors. There was a significant main effect for time since TBI on the Anxiety factor, F(4,

354) = 3.89, $p = .005$, $\eta^2_{partial} = .04$; Depression factor, $F(3, 317) = 5.79$, $p < .001$, $\eta^2_{partial} = .06$; and the Psychomotor factor, $F(4, 386) = 10.25$, $p < .001$, $\eta^2_{partial} = .10$. These results indicate a significant reduction in participants' mean HADS scores over time. Small effect sizes were found for time on the Anxiety factor, and medium effect sizes on the Depression and Psychomotor factors.

Bonferroni post-hoc comparisons for time, for each of the HADS factors are displayed in 'Output – Study 1' (Appendix B on the CD). Table B5 (Appendix B) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. Significant differences in mean anxiety scores were found between: the initial and 6-month follow-up ($p = .002$), and the initial and 12-month follow-up ($p = .024$). Significant differences in mean depression scores were found between the initial follow-up and: the 6-month ($p = .009$), 3-month ($p = .032$), 12-month ($p = .021$), and 24-month ($p = .031$) follow-ups. There was a significant difference in mean depression scores between the 1-month and 12-month ($p = .002$) follow-ups. Significant differences in mean psychomotor scores were found between the initial follow-up and: the 3-month ($p = .008$), 6-month ($p < .001$), 12-month ($p < .001$), and 24-month ($p < .001$) follow-ups.

Tests of between-subjects effects for relationship status on the HADS factors are shown in Table 5.19. The main effect comparing the two relationship status groups was non-significant for the Anxiety factor, $F(1, 93) = .04$, $p = .835$, $\eta^2_{partial} = .00$; Depression factor, $F(1, 93) = .05$, $p = .822$, $\eta^2_{partial} = .00$; and the Psychomotor factor, $F(1, 93) = .02$, $p = .893$, $\eta^2_{partial} = .00$. This indicates there was no difference between the mean HADS scores of the groups. The Time x Relationship Status interaction was non-significant for the Anxiety factor, $F(4, 354) = .37$, $p = .820$, $\eta^2_{partial} = .00$; Depression factor, $F(3, 317) = .99$, $p = .421$, $\eta^2_{partial} = .01$; and the Psychomotor factor $F(4, 386) = 1.41$, $p = .230$, $\eta^2_{partial} = .02$.

Table 5.19

Tests of Within-Subjects & Between-Subjects Effects for Relationship Status on the HADS Factors

HADS Factor/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	354	3.89**	.005	.04	.89
Relationship Status	1	93	.04	.835	.00	.13
Time x Rel. Status[a]	4	354	.37	.820	.00	.06
Depression						
Time since TBI[a]	3	317	5.79***	< .001	.06	.97
Relationship Status	1	93	.05	.822	.00	.29
Time x Rel. Status[a]	3	317	.99	.421	.01	.06
Psychomotor						
Time since TBI[a]	4	386	10.25***	< .001	.10	1.00
Relationship Status	1	93	.02	.893	.00	.45
Time x Rel. Status[a]	4	386	1.41	.230	.02	.05

Note. [a]Greenhouse-Geisser results are reported.
**$p < .01$. ***$p < .001$.

5.3.5 Employment Status

Cross-sectional sample. Independent samples *t*-tests were conducted at each follow-up to compare participants' HADS scores based on their employment status (Table 5.21). Two groups (employed/unemployed) were included in the analyses. Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 239 to 396 participants: employed (n = 202–349) and unemployed (n = 37–178; see Figure 5.1). Table 5.20 displays the mean HADS factor scores and standard deviations from these analyses. The mean scores are plotted for the Anxiety factor (Figure B15 – Appendix B), Depression factor (Figure 5.7), and Psychomotor factor (Appendix B – Figure B16).

Table 5.20

Descriptive Statistics for Employment Status on the HADS Factors – Cross-Sectional Sample

HADS Factor/ Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Employed	2.95	2.44	2.21	2.14	2.29	2.31
	(2.33)	(2.20)	(2.18)	(2.18)	(2.35)	(2.24)
Unemployed	3.52	3.46	2.78	3.29	2.67	3.12
	(2.73)	(2.44)	(2.39)	(2.87)	(2.60)	(3.00)
Depression						
Employed	1.41	1.28	1.11	1.22	1.20	1.15
	(1.60)	(1.49)	(1.46)	(1.66)	(1.68)	(1.61)
Unemployed	1.53	1.97	1.66	1.50	1.57	2.43
	(1.61)	(1.92)	(1.83)	(1.72)	(1.71)	(2.26)
Psychomotor						
Employed	3.81	3.30	2.82	2.86	2.82	2.76
	(2.19)	(2.29)	(2.06)	(2.25)	(2.26)	(2.10)
Unemployed	3.91	4.19	3.45	3.41	3.28	4.02
	(2.19)	(2.29)	(2.23)	(2.26)	(2.22)	(2.88)

Note. Mean values are displayed with standard deviations presented in parentheses.

Anxiety factor. On the Anxiety factor (Figure B15 in Appendix B; Table 5.21), the unemployed group showed a significantly higher mean HADS score than the employed group at the 1-month follow-up ($p < .05$). A trend was found for the unemployed group to display higher mean anxiety scores than the employed group at the 6-month ($p = .018$; when a more conservative alpha level was applied; see Section 5.2.5) and 3-month ($p = .094$) follow-ups. Cohen's *d* showed a small effect size at the 1-month and 3-month follow-ups, and a medium effect size at the 6-month follow-up.

Depression factor. On the Depression factor (see Figure 5.7; Table 5.21), the unemployed group displayed a significantly higher mean HADS score than the employed group at the 24-month follow-up ($p < .01$). A trend was found for the unemployed group to show higher mean depression scores at the 1-month ($p = .024$; when a more conservative alpha level was chosen) and 3-month ($p = .052$) follow-ups. Cohen's *d* showed a medium effect size at the 1-month and 3-month follow-ups, and a large effect size at the 24-month follow-up.

Psychomotor factor. On the Psychomotor factor (Figure B16 in Appendix B; Table 5.21), the unemployed group showed a significantly higher mean HADS score than the employed group at the 1-month follow-up ($p < .05$). A trend was found for the unemployed group to display higher mean psychomotor scores at the 3-month ($p = .051$) and 24-month follow-ups ($p = .027$; when a more conservative alpha level was chosen). Cohen's *d* showed a small effect size at the 1-month and 3-month follow-ups, and a large effect size at the 24-month follow-up.

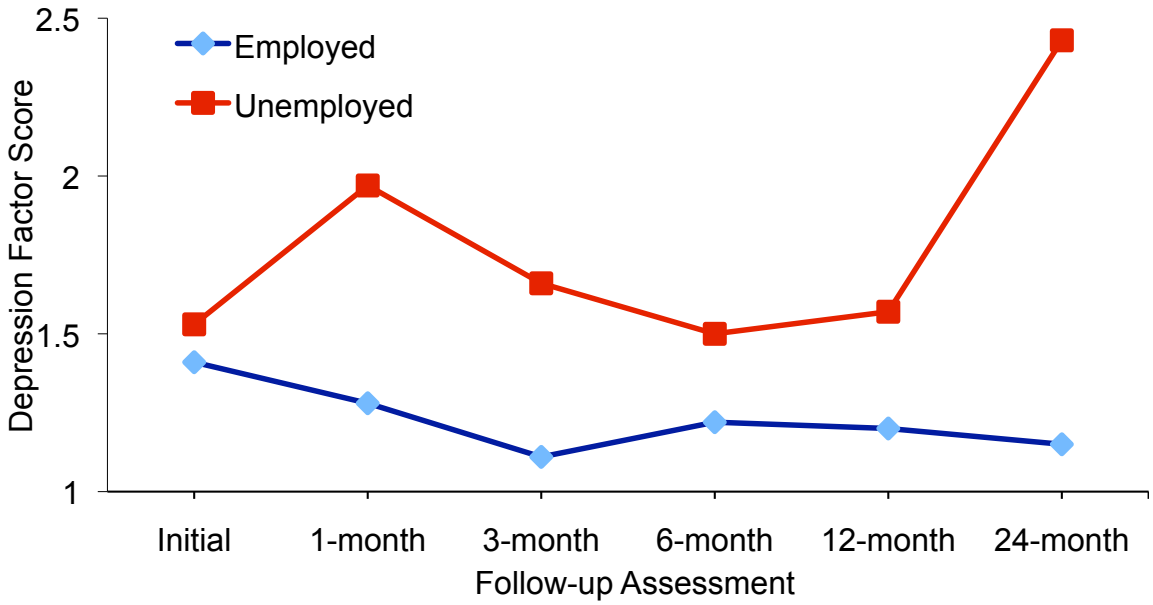

Figure 5.7. Mean depression scores for employment status (cross-sectional sample).

Table 5.21

Independent Samples t-Tests for Employment Status on the HADS Factors – Cross-Sectional Sample

Follow-up/ HADS Factor	*t*	*df*	*p*	Cohen's *d*	Power	Mean Difference	95% CI LL	95% CI UL
Initial (<15 days)								
Anxiety	-1.40	64	.167	-.35	.62	-.57	-1.38	.24
Depression	-.50	321	.621	-.06	.07	-.12	-.60	.36
Psychomotor	-.29	321	.775	-.03	.05	-.10	-.75	.56
1-month								
Anxiety	-2.55*	237	.011	-.33	.45	-1.02	-1.81	-.23
Depression	-2.08*	44	.044	-.63	.94	-.70	-1.36	-.02
Psychomotor	-2.18*	237	.030	-.28	.34	-.89	-1.70	-.09
3-month								
Anxiety	-1.68	394	.094	-.17	.44	-.57	-1.25	.10
Depression	-1.99	54	.052	-.54	.93	-.55	-1.11	.01
Psychomotor	-1.96	394	.051	-.20	.25	-.63	-1.27	.00
6-month								
Anxiety	-2.45*	45	.018	-.73	.99	-1.15	-2.09	-.20
Depression	-1.02	368	.310	-.11	.10	-.28	-.83	.26
Psychomotor	-1.47	368	.143	-.15	.15	-.55	-1.30	.19
12-month								
Anxiety	-.95	351	.342	-.10	.09	-.38	-1.17	.41
Depression	-1.30	351	.195	-.14	.13	-.37	-.92	.19
Psychomotor	-1.22	351	.225	-.13	.12	-.46	-1.21	.28
24-month								
Anxiety	-1.43	33	.161	-.50	1.00	-.80	-1.96	.34
Depression	-3.00**	32	.005	-1.06	1.00	-1.28	-2.14	-.41
Psychomotor	-2.31	32	.027	-.82	1.00	-1.25	-2.35	-.15

Note. $^{*}p < .05$. $^{**}p < .01$.

Longitudinal sample. Mixed between-within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' employment status on HADS scores across six time periods (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 62 participants who came to every follow-up assessment and completed the HADS. Following a frequency analysis, the data was analysed by dividing the sample into two groups: the employed group (n = 55) and the unemployed group (n = 7). Table 5.22 displays the mean HADS factor scores and standard deviations from these analyses. The mean HADS scores are plotted over time for the Anxiety factor (Figure 5.8), Depression factor (Figure B17 – Appendix B), and Psychomotor factor (Figure 5.9).

Table 5.22

Descriptive Statistics for Employment Status on the HADS Factors – Longitudinal Sample

HADS Factor/ Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Employed	2.32	1.90	1.65	1.40	1.78	1.84
	(1.89)	(1.86)	(1.71)	(1.63)	(1.78)	(1.67)
Unemployed	3.48	2.82	2.52	2.60	2.38	1.69
	(3.05)	(3.12)	(2.44)	(2.65)	(3.14)	(1.65)
Depression						
Employed	1.39	1.12	.83	.67	.69	.63
	(1.70)	(1.32)	(1.26)	(1.19)	(1.27)	(1.16)
Unemployed	1.66	1.35	1.21	1.16	1.65	1.09
	(1.39)	(1.43)	(1.41)	(1.57)	(1.79)	(.94)
Psychomotor						
Employed	3.42	2.97	2.46	2.23	2.20	2.12
	(1.97)	(2.26)	(1.99)	(1.86)	(1.88)	(1.66)
Unemployed	3.80	3.79	3.57	2.87	3.10	2.91
	(2.01)	(2.50)	(2.96)	(1.73)	(2.52)	(2.28)

Note. Mean values are displayed with standard deviations presented in parentheses.

Table 5.23 shows the tests of within-subjects effects for employment status on the HADS factors. There was a significant main effect for time since TBI on the Psychomotor factor, $F(4, 250) = 3.19$, $p = .013$, $\eta^2_{partial} = .05$. A trend for a main effect for time was found on the Anxiety factor, $F(4, 236) = 3.27$, $p = .013$, $\eta^2_{partial} = .05$. The main effect for time was non-significant on the Depression factor, $F(3, 190) = 1.70$, $p = .167$, $\eta^2_{partial} = .03$. The Time x Employment Status interaction was non-significant for the Anxiety factor, $F(4, 236) = 1.30$, $p = .271$, $\eta^2_{partial} = .02$; Depression factor, $F(3, 190) = .49$, $p = .698$, $\eta^2_{partial} = .01$; and the Psychomotor factor, $F(4, 250) = .23$, $p = .926$, $\eta^2_{partial} = .00$.

Tests of between subjects effects for employment status on the HADS factors are displayed in Table 5.23. The main effect comparing the two employment status groups was not significant for the Anxiety factor, $F(1, 60) = 1.44$, $p = .235$, $\eta^2_{partial} = .02$; Depression factor, $F(1, 60) = 1.27$, $p = .265$, $\eta^2_{partial} = .02$; and the Psychomotor factor, $F(1, 60) = 1.44$, $p = .236$, $\eta^2_{partial} = .02$. This indicates there was no difference between the mean scores of the groups.

Table B6 (Appendix B) shows significant and trend Bonferroni post-hoc comparisons for time on the Psychomotor factor (for the full table of post-hoc comparisons see 'Output – Study 1' in Appendix B on the CD). There was a significant difference in mean psychomotor scores between the 3-month and 6-month follow-up ($p < .05$), and a trend for differences in mean psychomotor scores between the initial and 6-month follow-up ($p = .089$).

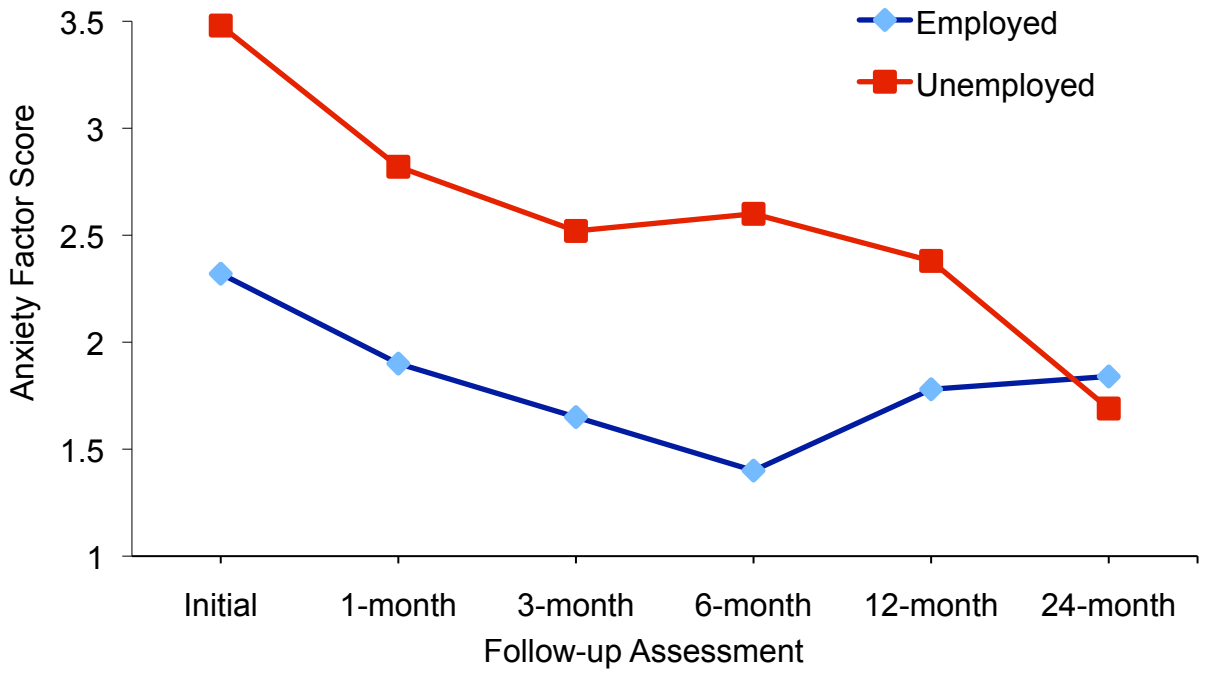

Figure 5.8. Mean anxiety scores over time for employment status (longitudinal sample).

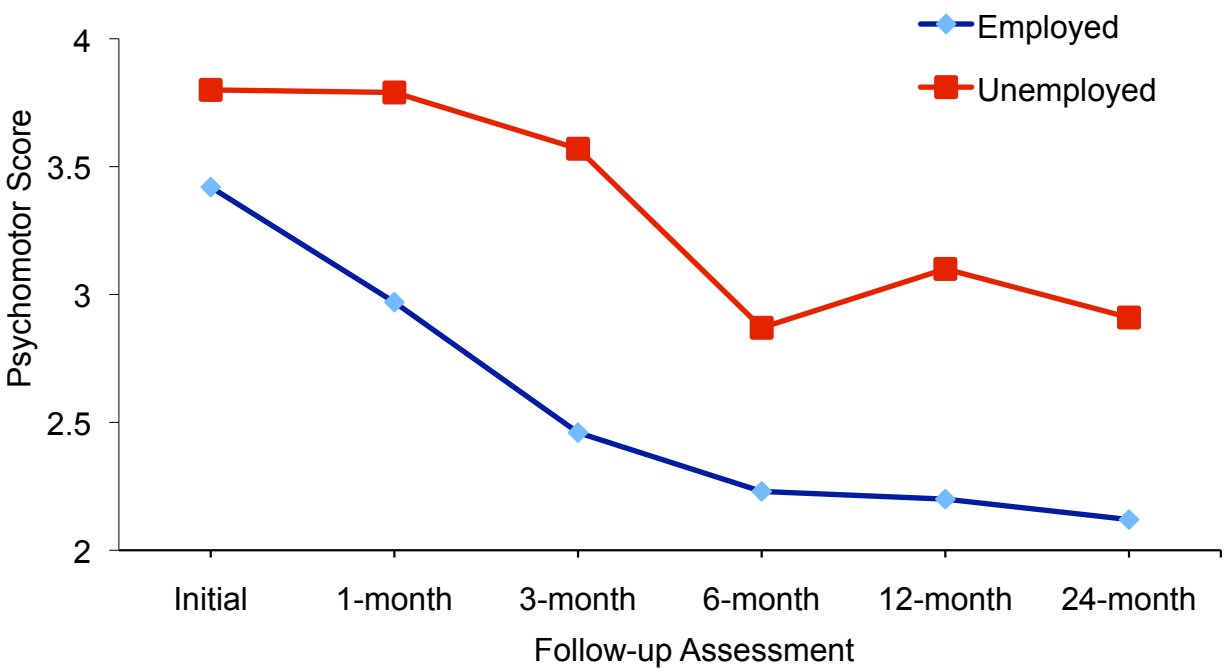

Figure 5.9. Mean psychomotor scores over time for employment status (longitudinal sample).

Table 5.23

Tests of Within-Subjects & Between-Subjects Effects for Employment Status on the HADS Factors

HADS Factor/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI [a]	4	236	3.27*	.013	.05	.83
Employment Status	1	60	1.44	.235	.02	.22
Time x Employment Status [a]	4	236	1.30	.271	.02	.40
Depression						
Time since TBI [a]	3	190	1.70	.167	.03	.45
Employment Status	1	60	1.27	.265	.02	.20
Time x Employment Status [a]	3	190	.49	.698	.01	.15
Psychomotor						
Time since TBI [a]	4	250	3.19*	.013	.05	.83
Employment Status	1	60	1.44	.236	.02	.22
Time x Employment Status [a]	4	250	.23	.926	.00	.10

Note. [a]Greenhouse-Geisser results are reported.
*$p < .05$.

5.3.6 Socio-economic Status (SES)

Cross-sectional sample. One-way between-subjects ANOVAs were conducted to assess the impact of participants' SES on HADS scores at each separate follow-up assessment (Table 5.25). Three groups were included in the analyses based upon the National Statistics Socio-economic Classification system (Office for National Statistics, 2014): SES 1 (employed in professional or managerial roles), SES 2 (employed in associate professional or skilled roles), and SES 3 (employed in semi-skilled or unskilled roles). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 202 to 349 participants: SES 1 (n = 42–69), SES 2 (n = 86–139), and SES 3 (n = 74–277; see Figure 5.1). Table 5.24 displays the mean HADS factor scores and standard deviations from these analyses. The mean scores are plotted for the Anxiety factor (Figure

5.10), Depression factor (Figure B18 – Appendix B), and the Psychomotor factor (Figure 5.11).

Table 5.24

Descriptive Statistics for SES on the HADS Factors - Cross Sectional Sample

HADS Factor/ Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
SES 1	2.77	1.74	1.74	1.75	1.57	1.93
	(2.10)	(1.59)	(1.69)	(1.83)	(1.71)	(1.87)
SES 2	2.76	2.49	1.78	1.83	2.18	2.22
	(2.38)	(2.26)	(1.91)	(1.85)	(2.29)	(2.28)
SES 3	3.24	2.77	2.83	2.64	2.75	2.60
	(2.34)	(2.36)	(2.46)	(2.52)	(2.58)	(2.35)
Depression						
SES 1	1.36	1.11	.87	1.10	.94	1.10
	(1.67)	(1.26)	(1.23)	(1.48)	(1.40)	(1.35)
SES 2	1.32	1.49	1.05	1.00	1.01	1.10
	(1.48)	(1.64)	(1.42)	(1.49)	(1.55)	(1.71)
SES 3	1.54	1.14	1.27	1.49	1.51	1.23
	(1.69)	(1.42)	(1.57)	(1.86)	(1.88)	(1.65)
Psychomotor						
SES 1	3.71	3.05	2.68	2.80	2.47	2.51
	(2.39)	(2.17)	(1.96)	(2.12)	(2.04)	(1.64)
SES 2	3.80	3.56	2.58	2.53	2.56	2.70
	(2.18)	(2.44)	(2.09)	(1.99)	(2.13)	(2.21)
SES 3	3.86	3.12	3.11	3.21	3.25	2.97
	(2.12)	(2.15)	(2.04)	(2.51)	(2.43)	(2.19)

Note. Mean values are displayed with standard deviations presented in parentheses.

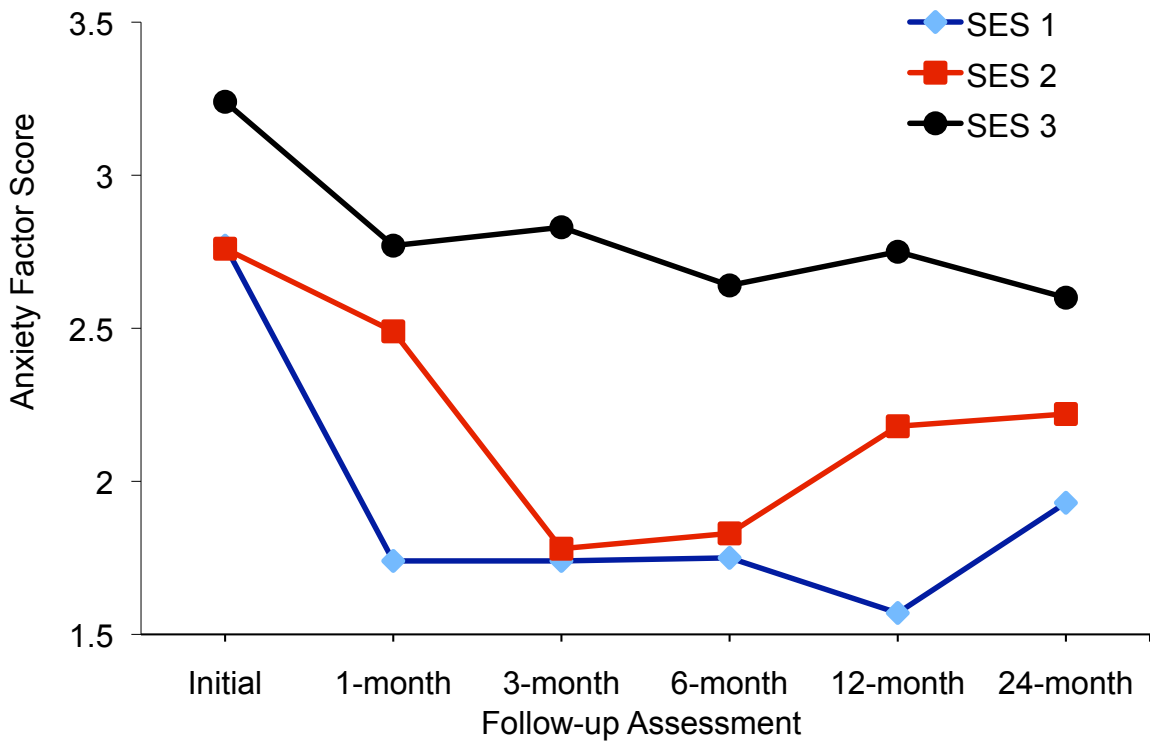

Figure 5.10. Mean anxiety factor scores for SES (cross-sectional sample).

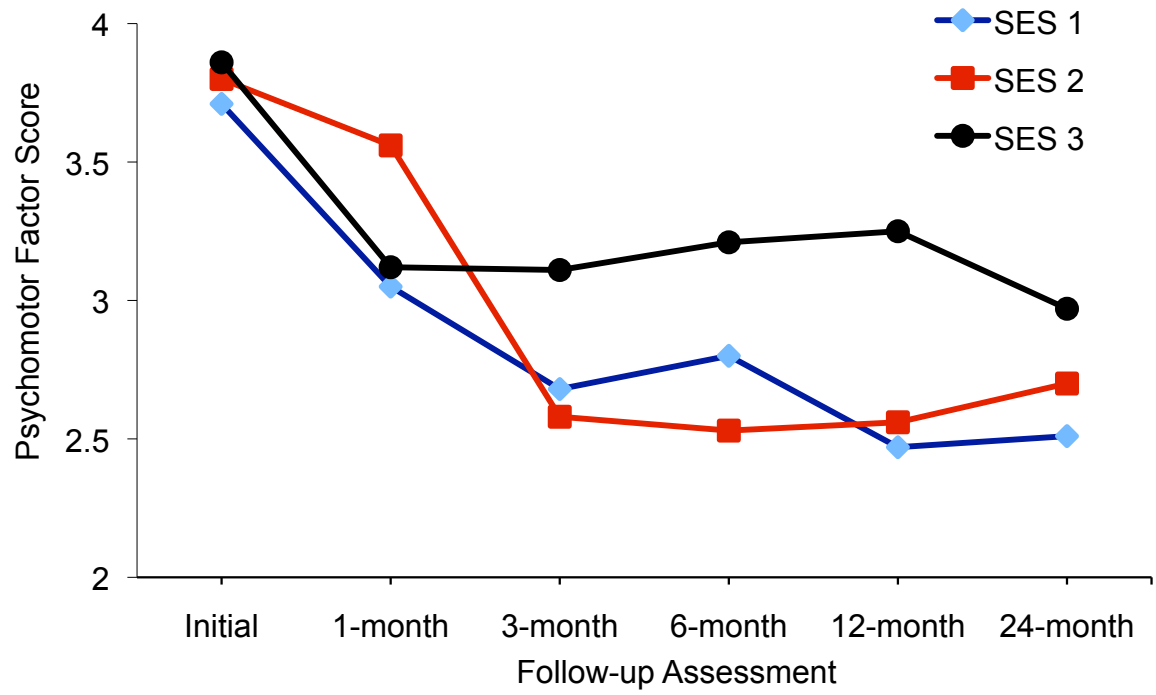

Figure 5.11. Mean psychomotor factor scores for SES (cross-sectional sample).

Anxiety factor. There were statistically significant differences in the mean anxiety scores of the groups ($p < .01$) at 3 months, 6 months, and 12 months, and a trend for differences in mean anxiety scores at 1 month ($p = .051$; Figure 5.10; Table 5.25). $\eta^2_{partial}$ showed a medium effect size at 3 months and small effect sizes at the other follow-ups.

Significant Tukey post-hoc tests for each of the HADS factors are displayed in Table 5.26 (for the full table of post-hoc tests for each of the HADS factors see 'Output – Study 1' in Appendix B on the CD). The SES 3 group showed significantly higher mean anxiety scores than the SES 1 group at the 1-month ($p < .05$), 3-month ($p < .01$), 6-month ($p < .05$), and 12-month ($p < .01$) follow-ups. The SES 3 group displayed significantly higher mean anxiety scores than the SES 2 group at the 3-month ($p < .001$) and 6-month ($p < .01$) follow-ups.

Depression factor. There were trends for differences in mean depression scores of the groups at the 6-month ($p = .050$) and 12-month ($p = .025$) follow-ups (Figure B18 – Appendix B; Table 5.25). For the Depression factor, $\eta^2_{partial}$ indicated small effect sizes. Tukey post-hoc tests (Table 5.26) showed at 6 months, the SES 3 group displayed a significantly higher mean depression score than the SES 2 group ($p < .05$). At the 12-month follow-up, the SES 3 group showed a significantly higher mean depression score than the SES 2 group ($p < .05$), and there was a trend for the SES 3 group to display a higher mean depression score than the SES 1 group ($p = .074$).

Psychomotor factor. There were trends for differences in mean psychomotor scores of the groups at the 3-month ($p = .077$), 6-month ($p = .050$), and 12-month ($p = .020$) follow-ups (see Figure 5.11; Table 5.25). For the Psychomotor factor, small effect sizes were noted using $\eta^2_{partial}$. Tukey post-hoc tests (Table 5.26) showed the SES 3 group reported significantly higher mean psychomotor scores than the SES 2 group at the 6- and 12-month follow-ups ($p < .05$), and there was a trend for the SES 3 group to display a higher mean psychomotor score

than the SES 2 group at 3 months (p = .074). At 12-months, there was a strong trend for the SES 3 group to show a higher mean psychomotor score than the SES 1 group (p = .065).

Table 5.25

ANOVA for Socioeconomic Status on the HADS Factors – Cross-Sectional Sample

Follow-up/	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
Initial (<15 days)						
Anxiety	2	269	1.38	.01	.254	.29
Depression	2	269	.54	.00	.586	.29
Psychomotor	2	269	.08	.00	.927	.29
1-month						
Anxiety	2	199	3.03	.03	.051	.60
Depression	2	187	1.55	.01	.216	.23
Psychomotor	2	199	1.04	.01	.356	.23
3-month						
Anxiety	2	314	11.77***	.06	< .001	.99
Depression	2	346	1.84	.01	.160	.37
Psychomotor	2	346	2.58	.01	.077	.37
6-month						
Anxiety	2	295	6.54**	.04	.002	.92
Depression	2	292	3.19*	.02	.043	.63
Psychomotor	2	327	3.03*	.02	.050	.63
12-month						
Anxiety	2	303	6.49**	.04	.002	.91
Depression	2	282	4.04*	.02	.019	.61
Psychomotor	2	270	4.14*	.02	.017	.61
24-month						
Anxiety	2	274	1.81	.01	.166	.30
Depression	2	274	.23	.00	.793	.30
Psychomotor	2	274	1.00	.01	.370	.30

Note. *p < .05. **p < .01. ***p < .001.

Table 5.26

Significant/Trend Tukey Post-Hoc Comparisons for SES on the HADS Factors – Cross-Sectional Sample

HADS Factor/ Follow-up	Comparison	*SE*	*p*
Anxiety			
1-month	SES 1 & SES 3	.42	.041
3-month	SES 1 & SES 3	.32	.002
3-month	SES 2 & SES 3	.25	< .001
6-month	SES 1 & SES 3	.31	.015
6-month	SES 2 & SES 3	.27	.007
12-month	SES 1 & SES 3	.36	.003
Depression			
6-month	SES 2 & SES 3	.20	.047
12-month	SES 1 & SES 3	.26	.074
12-month	SES 2 & SES 3	.21	.048
Psychomotor			
3-month	SES 2 & SES 3	.24	.074
6-month	SES 2 & SES 3	.28	.040
12-month	SES 1 & SES 3	.35	.065
12-month	SES 2 & SES 3	.28	.040

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' SES on HADS factor scores across six time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 55 participants who attended each follow-up assessment post-TBI and completed the HADS. Three groups were included in the analyses (Office for National Statistics, 2014): SES 1 = employed in professional or managerial roles (n = 14); SES 2 = employed in associate professional or skilled roles (n = 27); and SES 3 = employed in semi-skilled or unskilled roles (n = 14). Mean HADS factor scores and standard deviations

are shown in Table 5.27. The mean scores for each HADS factor are plotted over time in Appendix B (See Figures B19, B20, and B21).

Table 5.27

Descriptive Statistics for SES on the HADS Factors – Longitudinal Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
SES 1	1.93	1.71	1.50	1.54	1.65	1.75
	(1.68)	(1.65)	(1.78)	(1.72)	(1.34)	(1.37)
SES 2	1.94	1.64	1.33	1.14	1.70	1.84
	(1.78)	(1.57)	(1.64)	(1.34)	(1.98)	(1.90)
SES 3	3.47	2.60	2.40	1.77	2.04	1.95
	(1.97)	(2.45)	(1.65)	(2.04)	(1.83)	(1.58)
Depression						
SES 1	.88	1.31	.81	1.07	1.09	1.09
	(1.00)	(1.23)	(1.25)	(1.44)	(1.28)	(1.40)
SES 2	1.27	1.07	.97	.52	.63	.60
	(1.67)	(1.52)	(1.42)	(1.17)	(1.44)	(1.17)
SES 3	2.12	1.02	.57	.56	.41	.23
	(2.13)	(1.01)	(.96)	(.90)	(.78)	(.70)
Psychomotor						
SES 1	2.92	3.30	2.40	2.94	2.80	2.28
	(1.47)	(2.35)	(1.86)	(1.96)	(2.03)	(1.46)
SES 2	3.38	2.71	2.45	1.82	1.88	2.08
	(2.03)	(2.30)	(2.40)	(1.93)	(1.98)	(2.00)
SES 3	4.01	3.13	2.54	2.32	2.22	2.04
	(2.25)	(2.19)	(1.22)	(1.45)	(1.48)	(1.09)

Note. Mean values are displayed with standard deviations presented in parentheses.

Table 5.28 shows tests of within-subjects effects for the three SES groups on the HADS factors. A significant main effect was found for time since TBI on the Anxiety factor, $F(5, 207) = 4.24$, $p = .003$, $\eta^2_{partial} = .08$; Depression factor, $F(4, 175) = 6.26$, $p < .001$, $\eta^2_{partial} = .11$; and Psychomotor factor, $F(4, 201) = 8.53$, $p < .001$, $\eta^2_{partial} = .14$. These results indicate a significant reduction in participants' mean HADS scores over time. For the main effect of time, a medium effect size was found on the Anxiety and Depression factors, and a large effect size on the Psychomotor factor.

Tests of between-subjects effects for SES on the HADS factors are displayed in Table 5.28. The main effect comparing the three SES groups was not significant for the Anxiety factor, $F(2, 52) = 1.44$, $p = .246$, $\eta^2_{partial} = .05$; the Depression factor, $F(2, 52) = .21$, $p = .815$, $\eta^2_{partial} = .01$; and the Psychomotor factor, $F(2, 52) = .34$, $p = .712$, $\eta^2_{partial} = .01$, indicating no difference between the mean HADS scores of the groups.

There was a significant Time x SES interaction for the Depression factor, $F(7, 175) = 2.93$, $p = .007$, $\eta^2_{partial} = .10$, with a medium effect size. The interaction reflects that between the initial and the 1-month follow-up, the mean depression score of the SES 1 group increased while the mean depression score of the SES 3 group decreased (See Figure B20 – Appendix B). The Time x SES interaction was non-significant for the Anxiety, $F(8, 207) = 1.30$, $p = .269$, $\eta^2_{partial} = .05$, and Psychomotor factors, $F(8, 201) = 1.44$, $p = .183$, $\eta^2_{partial} = .05$. Bonferroni post-hoc comparisons for the each of the HADS factors are displayed in 'Output – Study 1' (Appendix B on the CD). Table B7 (Appendix B) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups.

Anxiety factor. A significant difference in mean anxiety scores was found between the initial and 6-month follow-up ($p = .001$; Figure B19 and Table B7 in Appendix B). A trend for differences in mean anxiety scores was found between the initial and 3-month follow-up ($p = .072$), and the 1-month and 6-month follow-up ($p = .072$).

Depression factor. Significant differences in mean depression scores were found between the initial follow-up and: the 3-month (p = .037), 6-month (p = .037), 12-month (p = .048), and 24-month (p = .024) follow-ups (Figure B20 and Table B7 in Appendix B). There was a significant difference in mean depression scores between the 1-month and 12-month follow-ups (p = .046). A strong trend was found for differences in mean depression scores between the 1-month and 24-month follow-up (p = .052).

Psychomotor factor. Significant differences in mean psychomotor scores were found between the initial follow-up and: the 3-month (p = .019), 6-month (p = .001), 12-month (p = .005), and 24-month (p = .003) follow-ups (Figure B21 and Table B7 in Appendix B). There was a significant difference in mean psychomotor scores between the 1-month follow-up and: the 6-month (p = .005), 12-month (p = .009), and 24-month follow-ups (p = .033).

Table 5.28

Tests of Within-Subjects & Between-Subjects Effects for SES on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI [a]	4	207	4.24**	.003	.08	.92
SES	2	52	1.44	.246	.05	.30
Time x SES [a]	8	207	1.30	.269	.05	.57
Depression						
Time since TBI [a]	4	175	6.26***	< .001	.11	.98
SES	2	52	.21	.815	.01	.08
Time x SES [a]	7	175	2.93**	.007	.10	.92
Psychomotor						
Time since TBI [a]	4	201	8.53***	< .001	.14	1.00
SES	2	52	.34	.712	.01	.10
Time x SES [a]	8	201	1.44	.183	.05	.63

Note. [a]Greenhouse-Geisser results are reported.
**p < .01. ***p < .001.

5.3.7 Study 1 – Correlations

The relationship between the HADS Anxiety, Depression, and Psychomotor factors, age and pre-morbid intelligence (as measured by the NART FSIQ) at the initial follow-up was investigating using Pearson product-moment correlation coefficients (Table 5.29). Highly significant ($p < .001$) strong positive correlations were found between each set of the HADS factors. A medium positive correlation was found between age and NART FSIQ ($p < .001$), indicating older age related to higher NART FSIQ scores. Very small correlations were found when correlating each of the HADS factors with age ($p < .05$), and when correlating each of the HADS factors with NART FSIQ ($p < .001$).

Table 5.29

Means, Standard Deviations and Intercorrelations for HADS Factor Scores and Demographic Variables at the Initial Follow-up

Variable	*M*	*SD*	1	2	3	4	5
1. Anxiety Factor	3.21	2.55	–				
2. Depression Factor	1.63	1.76	.60***	–			
3. Psychomotor Factor	3.90	2.29	.69***	.72***	–		
4. Age	35.86	16.80	-.00	.06	.00	–	
5. NART FSIQ	99.82	10.71	-.20***	-.06	-.10	.35***	–

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

5.3.8 Using Initial Demographic Variables to Predict HADS Scores

A series of stepwise multiple regression analyses were conducted to assess the ability of a number of demographic variables measured at the initial follow-up assessment to predict participants' HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI. The predictor variables included in the analyses are listed in Section 5.2.4. Sample sizes varied according to the follow-up assessment and the variable measured (N = 126–280 participants; see 'Output – Study 1' in Appendix B on the CD). Means, standard deviations, and Pearson correlation coefficients for the regression analyses are show in Table 5.30. All

correlation coefficients were $r < .30$, indicating small relationships between the initial clinical predictor variables and the HADS factors at each follow-up.

Table 5.30

Means, Standard Deviations and Correlations for Initial Demographic Predictor Variables and HADS Factor Scores

Variable	*M*	*SD*	Age	NART FSIQ
Anxiety				
3-months	2.50	2.42	.01	-.23***
6-months	1.99	2.16	.05	-.23***
12-months	2.02	2.16	.06	-.10
24-months	2.33	2.29	.06	-.12
Depression				
3-months	1.18	1.60	.10*	-.24***
6-months	1.00	1.51	.26***	-.10
12-months	1.04	1.56	.22***	-.05
24-months	1.19	1.75	.09	-.09
Psychomotor				
3-months	2.98	2.23	.04	-.24***
6-months	2.57	2.04	.11*	-.17**
12-months	2.53	2.14	.11*	-.15*
24-months	2.67	2.27	.08	-.13*

Note. Pearson Correlation Coefficients are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

Each of the stepwise regression analyses is displayed in Tables B8, B9, and B10 (Appendix B). The final prediction models and the accompanying regression equations are presented in Table 5.31.

Anxiety factor. Two regression models were produced for predicting HADS anxiety scores at 3 months (Table B8 – Appendix B). The best model (Table 5.31) was found at Step 1 and consisted of NART FSIQ, explaining 5% of the variance in anxiety ($R^2 = .05$, $F = 7.15$

[1, 132], $p = .008$). Although, gender was included in Step 2 of the model and explained an additional 2% of the variance, it did not reach statistical significance ($p = .145$).

Two regression models were produced for predicting HADS anxiety scores at 6 months (Table 5.31). NART (4 groups) was entered at Step 1, explaining 6% of the variance in anxiety. Gender was added to the model in Step 2, the total variance explained by the model as a whole was 9% ($R^2 = .09$, $F = 6.69$ [2, 130], $p = .002$). Of the two variables, NART (4 groups) made the largest unique contribution to the model (β = -.27), however gender also provided a statistically significant contribution (β = -.19). No regression models were produced for predicting HADS anxiety scores at 12 and 24 months.

Depression factor. Three regression models were produced for predicting HADS depression scores at 3 months (Table 5.31). NART FSIQ was entered at Step 1, explaining 6% of the variance in depression. Age was added to the model in Step 2, the total variance explained by the model as a whole was 10%. The final model consisted of the predictors NART FSIQ, age, and relationship status, and explained 12% of the variance in depression scores at 3 months ($R^2 = .12$, $F = 5.71$ [3, 130], $p = .001$). Of these three variables, NART FSIQ made the largest unique contribution to the model (β = -.32), with age also providing a statistically significant contribution (β = .23). There was a trend for relationship status to be included in the model (β = .14; $p = .089$).

Two regression models were produced for predicting HADS depression scores at 6 months (Table 5.31). Age (4 groups) was entered at Step 1, explaining 7% of the variance in depression. NART FSIQ was added to the model in Step 2, the total variance explained by the model as a whole was 11% ($R^2 = .11$, $F = 7.85$ [2, 130], $p = .001$). Of the two variables, age (4 groups) made the largest unique contribution to the model (β = .33), however NART FSIQ also provided a statistically significant contribution (β = -.20).

Two regression models were produced for predicting HADS depression scores at 12 months (Table B9 – Appendix B). The best model (Table 5.31) was found at Step 1 and

consisted of age, explaining 5% in depression (R^2 = .05, F = 6.15 [1, 120], p = .015). Although NART FSIQ was added to the model in Step 2 and explained an additional 2% of the variance, it did not reach statistical significance (p = .117). No regression models were produced for predicting HADS depression scores at 24 months.

Psychomotor factor. Three regression models were produced for predicting HADS psychomotor scores at 3 months (Table 5.31). NART FSIQ was entered at Step 1, explaining 6% of the variance in psychomotor scores. Relationship status was added to the model in Step 2, the total variance explained by the model as a whole was 8%. The final model consisted of the predictors NART FSIQ, relationship status, and age, and explained 10% of the variance in psychomotor scores at 3 months (R^2 = .10, F = 4.89 [3, 130], p = .003). NART FSIQ made the largest unique contribution to the model (β = -.29), with relationship status also providing a statistically significant contribution (β = .17). Although age was included in the model (β = .16), it did not reach statistical significance (p = .071).

Two regression models were produced for predicting HADS psychomotor scores at 6 months (Table 5.31). NART FSIQ was entered at Step 1, explaining 3% of the variance in psychomotor. Age was added to the model in Step 2, the total variance explained by the model as a whole was 6% (R^2 = .06, F = 4.04 [2, 130], p = .020). NART FSIQ made the largest unique contribution to the model (β = -.23), however age also provided a statistically significant contribution (β = .18).

Two regression models were produced for predicting HADS psychomotor scores at 12 months (Table 5.31). NART FSIQ was entered at Step 1 explaining 2% of the variance in psychomotor scores. Age was added to the model in Step 2, the total variance explained by the model as a whole was 6% (R^2 = .06, F = 3.45 [2, 119], p = .035). Of the two variables, NART FSIQ made the largest unique contribution to the model (β = -.22). Although age was included in the model (β = .19) it did not reach statistical significance (p = .051). No regression models were produced for predicting HADS psychomotor scores at 24 months.

Table 5.31

Final Regression Models for Predicting HADS Factor Scores Using Initial Demographic Variables

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	NART FSIQ	-.05	.02	-.23	-2.67	.008	*Y* = 7.66 + -.05 (NART FSIQ)
	6-months						
	NART (4 groups)	-.59	.19	-.27	-3.18	.002	*Y* = 4.94 + -.59 (NART 4 groups)
	Gender	-.84	.38	-.19	-2.20	.030	+ -.84 (Gender)
Depression	3-months						
	NART FSIQ	-.05	.01	-.32	-3.64	< .001	*Y* = 4.50 + -.05 (NART FSIQ)
	Age	.02	.01	.23	2.60	.010	+ .02 (Age)
	Relationship Status	.46	.27	.14	1.71	.089	+ .46 (Relationship status)
	6-months						
	Age (4 groups)	.47	.13	.33	3.78	< .001	*Y* = 2.80 + .47 (Age 4 groups)
	NART FSIQ	-.03	.01	-.20	-2.26	.025	+ -.03 (NART FSIQ)
	12-months						
	Age	.02	.01	.22	2.48	.015	*Y* = .31 + .02 (Age)
Psychomotor	3-months						
	NART FSIQ	-.06	.02	-.29	-3.34	.001	*Y* = 7.29 + -.06 (NART FSIQ)
	Relationship status	.75	.38	.17	1.99	.049	+ .75 (Relationship Status)
	Age	.02	.01	.16	1.82	.071	+ .02 (Age)
	6-months						
	NART FSIQ	-.04	.02	-.23	-2.55	.012	*Y* = 6.25 + -.04 (NART FSIQ)
	Age	.02	.01	.18	2.03	.045	+ .02 (Age)
	12-months						
	NART FSIQ	-.05	.02	-.22	-2.31	.023	*Y* = 6.45 + -.05 (NART FSIQ)
	Age	.02	.01	.19	1.97	.051	+ .02 (Age)

5.3.9 Using 1-Month Demographic Variables to Predict HADS Scores

A series of stepwise multiple regression analyses were conducted to assess the ability of a number of demographic variables measured at the 1-month follow-up assessment to predict participants' HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI. The predictor variables included in the analyses are listed in Section 5.2.4. Sample sizes varied according to the follow-up assessment and the variable measured (N = 114–271 participants; see 'Output – Study 1' in Appendix B on the CD).

Means, standard deviations, and Pearson correlation coefficients for the regression analyses are shown in Table 5.32. Highly significant ($p < .001$) medium size correlations in a negative direction were found between the HADS Anxiety factor and 1-month NART FSIQ at 3 months and 6 months, and between the HADS Depression factor and 1-month NART FSIQ at 3 months. All other correlation coefficients indicated small relationships ($r < .30$).

Table 5.32

Means, Standard Deviations and Correlations for 1-month Demographic Predictor Variables and HADS Factor Scores

Variable	*M*	*SD*	Age	NART FSIQ
Anxiety				
3-months	2.39	2.29	-.01	-.35***
6-months	2.00	2.19	.03	-.33***
12-months	2.01	2.22	.01	-.20**
24-months	.26	2.34	.04	-.25***
Depression				
3-months	1.15	1.62	.09	-.34***
6-months	1.11	1.65	.23***	-.19**
12-months	1.03	1.57	.19**	-.15*
24-months	1.19	1.83	.07	-.13
Psychomotor				
3-months	2.98	2.23	.04	-.24***
6-months	2.62	2.10	.09	-.28***
12-months	2.53	2.21	.09	-.27***
24-months	2.71	2.34	.01	-.27***

Note. Pearson Correlation Coefficients are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

Each of the stepwise regression analyses is displayed in Tables B11, B12, and B13 (Appendix B). The final prediction models and the accompanying regression equations are presented in Table 5.33.

Anxiety factor. Two regression models were produced for predicting HADS anxiety scores at 3 months (Table B11 – Appendix B). The best model (Table 5.33) was found at Step 1 and consisted of NART FSIQ, explaining 12% of the variance in anxiety (R^2 = .12, F = 16.22 [1, 117], p < .001). Although, gender was included in Step 2 of the model, it did not reach statistical significance (p = .124).

Two regression models were produced for predicting HADS anxiety scores at 6 months (Table B11 – Appendix B). The best model (Table 5.33) was found at Step 1 and consisted of NART FSIQ, explaining 11% of the variance in anxiety (R^2 = .11, F = 14.04 [1, 117], p < .001). Although gender was included in Step 2 of the model and explained an additional 2% of the variance, it did not reach statistical significance (p = .106).

Two regression models were produced for predicting HADS anxiety scores at 12 months (Table 5.33). NART (4 groups) was entered at Step 1, explaining 4% of the variance in anxiety. Gender was added to the model in Step 2, the total variance explained by the model as a whole was 7% (R^2 = .07, F = 4.13 [2, 104], p = .019). Of the two variables, NART (4 groups) made the largest unique contribution to the model (β = -.22), however, there was a trend (p = .064) for gender to provide a contribution (β = -.18).

One regression model was produced for predicting HADS anxiety scores at 24 months (Table 5.33). NART (4 groups) was entered at Step 1, explaining 7% of the variance in anxiety scores (R^2 = .07, F = 7.05 [1, 94], p = .009).

Depression factor. Two regression models were produced for predicting HADS depression scores at 3 months (Table 5.33). NART FSIQ was entered at Step 1, explaining 12% of the variance in depression. Age (4 groups) was added to the model in Step 2, the total

variance explained by the model as a whole was 17% (R^2 = .17, F = 11.55 [2, 116], p < .001). Of the two variables, NART FSIQ made the largest unique contribution to the model (β = -.42), however age (4 groups) also provided a statistically significant contribution (β = .23).

Three regression models were produced for predicting HADS depression scores at 6 months (Table 5.33). Age (4 groups) was entered at Step 1, explaining 6% of the variance in depression. The best model was found at Step 2 and consisted of age (4 groups) and NART FSIQ, the total variance explained by the model as a whole was 12% (R^2 = .12, F = 8.02 [2, 116], p = .001). Both age (4 groups) and NART FSIQ provided statistically significant contributions to the model (β = .30 and -.26, respectively). Although, gender was included in the model in Step 3 and contributed an additional 2% to the variance explained, it did not reach statistical significance (p = .125).

Two regression models were produced for predicting HADS depression scores at 12 months (Table 5.33). Age was entered at Step 1 explaining 3% of the variance in depression. NART FSIQ was entered in Step 2, with the model as a whole explaining 8% of the variance in depression (R^2 = .08, F = 4.73 [2, 104], p = .001). Age made the largest unique contribution to the model (β = .26), however NART FSIQ also provided a statistically significant contribution (β = -.23).

One regression model was produced for predicting HADS depression scores at 24 months (Table 5.33). Employment was entered at Step 1, explaining 4% of the variance in depression (R^2 = .04, F = 3.51 [1, 94], p = .064).

Psychomotor factor. Three regression models were produced for predicting HADS psychomotor scores at 3 months (Table B13 – Appendix B). The best model (Table 5.33) consisted of NART FSIQ and age, explaining 12% of the variance in psychomotor (R^2 = .12, F = 9.48 [2, 116], p < .001). Of the two variables, NART FSIQ made the largest unique contribution to the model (β = -.40) and there was a trend for age to provide a statistically

significant contribution (β = .18; p = .079). Although relationship status was included in the model in Step 3, it did not reach statistical significance (p = .106).

Two regression models were produced for predicting HADS psychomotor scores at 6 months (Table 5.33). NART FSIQ was entered at Step 1, explaining 8% of the variance in psychomotor. Age was added to the model in Step 2, the total variance explained by the model as a whole was 10% (R^2 = .10, F = 6.72 [2, 116], p = .002). Of the two variables, NART FSIQ made the largest unique contribution to the model (β = -.32). Although age was included in the model (β = .17) it did not reach statistical significance (p = .063).

Two regression models were produced for predicting HADS psychomotor scores at 12 months (Table 5.33). NART FSIQ was entered at Step 1, explaining 7% of the variance in psychomotor. Age was added to the model in Step 2, the total variance explained by the model as a whole was 11% (R^2 = .11, F = 6.32 [2, 104], p = .003). Of the two variables, NART FSIQ made the largest unique contribution to the model (β = -.33), although age also provided a statistically significant contribution (β = .20).

One regression model was produced for predicting HADS psychomotor scores at 24 months (Table 5.33), with NART (4 groups) explaining 8% of the variance in psychomotor scores (R^2 = .08, F = 8.47 [1, 94], p = .005).

Table 5.33

Final Regression Models for Predicting HADS Factor Scores Using 1-month Demographic Variables

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	NART FSIQ	-.07	.02	-.35	-4.03	< .001	*Y* = 9.69 + -.07 (NART FSIQ)
	6-months						
	NART FSIQ	-.07	.02	-.33	-3.75	< .001	*Y* = 8.93 + -.07 (NART FSIQ)
	12-months						
	NART (4 groups)	-.50	.22	-.22	-2.31	.023	*Y* = 4.63 + -.50 (NART 4 groups)
	Gender	-.80	.43	-.18	-1.87	.064	+ -.80 (Gender)
	24-months						
	NART (4 groups)	-.62	.23	-.26	-2.66	.009	*Y* = .97 + -.62 (NART 4 groups)
Depression	3-months						
	NART FSIQ	-.06	.01	-.42	-4.67	< .001	*Y* = 6.57 + -.06 (NART FSIQ)
	Age (4 groups)	.35	.14	.23	2.60	.011	+ .35 (Age 4 groups)
	6-months						
	Age (4 groups)	.47	.14	.30	3.36	.001	*Y* = 4.20 + .47 (Age 4 groups)
	NART FSIQ	-.04	.01	-.26	-2.88	.005	+ -.04 (NART FSIQ)
	12-months						
	Age	.02	.01	.26	2.61	.010	*Y* = 3.82 + .02 (Age)
	NART FSIQ	-.04	.02	-.23	-2.36	.020	+ -.04 (NART FSIQ)
	24-months						
	Employment	1.08	.58	.19	1.87	.064	*Y* = -.01 + 1.08 (Employment)
Psychomotor	3-months						
	NART FSIQ	-.08	.02	-.40	-4.34	< .001	*Y* = 10.25 + -.08 (NART FSIQ)
	Age	.02	.01	.16	1.78	.079	+ .02 (Age)
	6-months						
	NART FSIQ	-.06	.02	-.32	-3.52	.001	*Y* = 8.35 + -.06 (NART FSIQ)
	Age	.02	.01	.17	1.88	.063	+ .02 (Age)

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Psychomotor	12-months						
	NART FSIQ	-.07	.02	-.33	-3.42	.001	*Y* = 8.96 + -.07 (NART FSIQ)
	Age	.02	.01	.20	2.00	.048	+ .02 (Age)
	24-months						
	NART (4 groups)	-1.39	.48	-.29	-2.91	.005	*Y* = 4.98 + -1.39 (NART 4 groups)

5.4 Study 1 - Discussion

Study 1 aimed to examine differences in TBI participants' scores on the HADS based on the demographic variables: age, gender, estimated pre-morbid intelligence, relationship status, employment status, and socioeconomic status. Data for this study was collected at six follow-up assessments over 2 years after participants sustained a TBI. In order to provide a detailed exploration of the relationship between participants' mood outcome and the demographic variables, both longitudinal sample and cross-sectional sample analyses were performed on the data, as well as correlations and multiple regression analyses.

5.4.1 Descriptive Statistics

Descriptive statistics were consistent with past research and the large sample sizes suggest the findings reflect the true scores of the patients within the TBI clinical group (Hillier, Hiller, & Metzer, 1997; Khan et al., 2003). The descriptive statistics were generally consistent for both the longitudinal and cross-sectional samples. However, TBI participants who attended each follow-up tended to be slightly older and were more likely to have mild TBI. A higher percentage of female participants were found in the longitudinal sample compared to the cross-sectional sample.

As expected, the median and mean ages of the cross-sectional sample were relatively young (32 and 36 years of age respectively), with a larger percentage of males (65%) than females. The majority of participants in the sample had mild TBI (approximately 70%), which is consistent with the findings from previous TBI epidemiology studies (Tate et al.,

1998). In the cross-sectional sample, participants' median and mean estimated pre-morbid IQ scores were in the average range (100 and 99, respectively). At the initial follow-up, the majority of the participants were employed (84%) and half of the participants in the sample were in a significant relationship.

Overall, the descriptive statistics indicate both the cross-sectional and longitudinal samples are representative samples of the TBI clinical group, which gives weight to the findings from the present research.

5.4.2 Mood Recovery

In the longitudinal sample analyses, TBI participants showed a significant reduction in their anxiety, depression, and psychomotor HADS scores over time, with lower levels of symptoms reported at 2 years following injury. The size of these effects varied across the demographic variables measured, ranging from small to medium for the Anxiety and Depression HADS factors, and from small to large for the HADS Psychomotor factor. Overall the results indicate that as a clinical group, TBI patients tend to experience significant recovery from mood problems over a 2-year time period following TBI.

At each follow-up, participants' mean HADS depression scores were generally higher than the mean HADS depression scores provided by the Dunbar et al. (2000) normative sample. This suggests that many of the TBI participants in the present study continued to show depression symptoms over the 2-year period, at such a level that may warrant clinical attention. Participants' HADS anxiety and psychomotor scores tended to be comparatively higher than the normative sample at the earlier follow-ups (initial follow-up – anxiety; initial and 1-month follow-ups – psychomotor), with little mean differences at the later follow-ups. These results suggest the TBI participants in the present study showed early recovery in their anxiety and psychomotor symptoms, at such a level that they have returned to "normal."

Participants displayed varying patterns of recovery, depending on the HADS factor investigated—providing strong support for the Skilbeck et al. (2011) HADS three-factor model. Overall, there were clear differences between the sizes of the mean scores for each of the HADS factors, with participants consistently scoring highest on the Psychomotor factor and lowest on the Depression factor at each follow-up assessment.

5.4.3 Gender

The hypothesis, *female TBI patients would score higher on the HADS factors than male TBI patients,* was supported by the results of the cross-sectional sample analyses. At each follow-up assessment, female participants reported significantly higher anxiety scores than male participants. Female participants reported significantly higher depression scores than male participants at the initial and 3-month follow-ups, with a trend for higher depression scores than male participants at 6 months. They also reported significantly higher psychomotor scores than male participants at 3 months and there was a trend for female participants to have a higher psychomotor score than male participants at 1 month.

The findings from the analyses of gender indicated there were small effect sizes for female TBI patients to experience higher levels of anxiety, depression, and psychomotor symptoms after TBI compared with male TBI patients. This supports the increasing body of research that has found females experience more symptoms of anxiety and depression compared to males post-TBI (Glenn et al., 2001; Hibbard et al., 1998; Sliwinski et al., 1998), but also suggests that of the genders, females fare worse in the psychomotor domain. These gender differences may be explained by females experiencing more severe traumatic responses from TBI, or differing ways in which males and females report symptoms (e.g., females may find it easier to admit to symptoms of mood disturbance because of greater emotional openness; Farace & Alves, 2000).

5.4.4 Age

The hypothesis, *older TBI patients would score higher on the HADS factors than younger TBI patients*, was not supported by the results of the cross-sectional sample analyses. In contrast, the oldest TBI participants (60 years +) consistently reported the lowest anxiety and psychomotor scores compared to participants in the other age groups. Over the 2-year period, participants aged 60 years + tended to show significantly lower anxiety and psychomotor scores than participants aged 26–40 years and 41–59 years. Participants aged 60 years + also displayed significantly lower depression scores than participants aged 41–59 years at 3 months and significantly lower depression scores than participants aged 26–40 years at the initial follow-up.

Overall, the findings from the analyses of age indicated older TBI patients experienced lower levels of anxiety, depression, and psychomotor symptoms after their injury compared to other age groups. Interestingly, middle age TBI patients (aged 41–59 years) were found to report the highest levels of mood symptoms. These participants tended to show significantly higher anxiety and psychomotor scores than participants aged 60 years +, and significantly higher anxiety, depression, and psychomotor scores across the post-injury follow-ups, when compared to participants in the lowest age group (16–25 years). These findings support the research of J. Ponsford (personal communication, May, 2008), which found TBI patients between the ages of 50 and 60 years showed the highest levels of depression and anxiety in a TBI sample. During the middle adulthood stage, the individual tends to experience major life stressors (e.g., children leaving home, death of a parent, career changes) and may become more aware of their own aging and physical decline (Levinson, 1978). Due to these existing stressors, middle age TBI patients may be more vulnerable to developing disturbances in mood when facing the additional stress of a head injury.

The greatest effect sizes for age differences were found in participants' anxiety and depression levels at the 1-month follow-up. At 1 month, it is likely that many TBI patients (particularly with mild TBI) would have begun to reintegrate into their pre-injury roles (e.g., returning to work or study and performing household tasks). Perhaps at this time period, the TBI patient becomes aware of the impact their physical and cognitive difficulties related to the injury has upon their ability to function effectively in these roles.

5.4.5 Estimated Pre-morbid Intelligence

As predicted, TBI patients with lower est. pre-morbid IQ showed larger scores on the HADS factors than TBI patients with higher est. pre-morbid IQ. In the two-group cross-sectional sample analyses, participants with lower est. pre-morbid IQ (< 100) showed significantly greater anxiety scores over the first 6 months post-injury, compared to participants with higher est. pre-morbid IQ (> = 100). Participants with lower est. pre-morbid IQ reported significantly greater depression and psychomotor scores at 1 month, and there was a trend for participants with lower est. pre-morbid IQ to show greater psychomotor scores at 3 months, when compared to participants with higher est. pre-morbid IQ. The four-group cross-sectional analyses (below average IQ, lower average IQ, higher average IQ, above average IQ) also supported the est. pre-morbid IQ hypothesis. These findings indicated participants with below average est. pre-morbid IQ tended to report the highest HADS scores and TBI participants with above average est. pre-morbid IQ tended to report the lowest HADS scores over the 2-year period, with a number of significant findings between these two groups.

Overall, the findings from the analyses of est. pre-morbid IQ indicated there were small effect sizes for TBI patients with lower est. pre-morbid IQ to experience greater levels of anxiety, depression, and psychomotor symptoms following TBI, compared with TBI patients with higher est. pre-morbid IQ. These findings are important, as very few studies have

examined the relationship between mood post-TBI and est. pre-morbid IQ. The findings support the research of Skell et al. (2000), which found the best predictor of TBI patients' emotional distress after TBI (mean time since injury = 21.6 months), was their estimated level of pre-morbid IQ, however, the present findings suggest TBI patients with lower est. pre-morbid IQ are also vulnerable to mood problems closer to the injury. TBI patients with lower est. pre-morbid IQ may have additional difficulties adjusting to life after brain injury, due to a combination of low IQ and the decreased cognitive abilities attributed to the injury. Therefore, day-to-day tasks involving cognition may become much more difficult. As pre-morbid IQ has been shown to be associated with education, employment status, and SES (Groth-Marnat, 2009), it is likely that TBI patients with lower pre-morbid IQ would experience greater health and literacy problems, which may in turn, affect their emotional adjustment. The greater effect size found at 1 month suggests that this may be a pivotal time-point where a patient with lower pre-morbid IQ is most affected by these additional stressors faced post-brain injury.

5.4.6 Relationship Status

The cross-sectional sample analyses supported the hypothesis, *TBI patients in a significant relationship would score lower on the HADS factors compared with TBI patients not in a significant relationship*. TBI participants not in a relationship showed significantly higher anxiety scores at the 24-month follow-up and a trend for higher anxiety scores at 3 months, when compared with TBI participants in a relationship. A trend was found for participants not in a relationship to report higher depression scores than participants in a relationship at 3 months. Participants not in a relationship displayed a significantly higher psychomotor score at the 3-month follow-up and a trend for a higher psychomotor score at 24 months, when compared with participants in a relationship.

The findings from the analyses of relationship status indicated there were small effect sizes for TBI patients not in a significant relationship to have higher levels of anxiety, depression, and psychomotor symptoms following TBI, compared with TBI patients in a significant relationship. These results support the research of Ponsford et al. (2000), which found that post-TBI, unmarried TBI patients were more likely to report distress than married TBI patients. Differences in mood based on relationship status may be related to the roles a partner plays in a significant relationship, such as providing support for the emotional, physical, and cognitive effects of TBI (Bennett & Raymond, 1997).

5.4.7 Employment Status

The prediction, *unemployed TBI patients would display higher scores on the HADS factors*, was supported by the cross-sectional sample analyses, with unemployed TBI participants tending to score significantly higher on the HADS than employed TBI participants across the follow-up assessments. Unemployed TBI participants showed significantly higher anxiety scores than employed TBI participants at 1 month and there was a trend for unemployed TBI participants to report higher anxiety scores at the 3- and 6-month follow-ups. Unemployed TBI participants displayed significantly higher depression scores at 24 months and a trend for higher depression scores at 1 month and 3 months, compared with employed TBI patients. Unemployed TBI participants reported significantly higher psychomotor scores at 1 month and a trend for higher psychomotor scores at 3 months and 24 months, when compared with employed TBI participants.

The findings from the analyses of employment status indicated unemployed TBI patients had higher levels of anxiety, depression, and psychomotor symptoms after injury, compared with employed TBI patients. In particular, the greatest effect sizes were found for differences in anxiety scores at 6 months, and for differences in depression scores at 1 month, 3 months, and 24 months. The results support a body of research that has consistently found a

relationship between employment and mood after TBI (e.g., Fraunlic et al., 2004; Sander et al., 1997). The detrimental effects of TBI may result in unemployment for some patients and those who are unemployed post-TBI may spend more time dwelling on the problems associated with the injury. The present results also suggest patients' unemployed pre-TBI are more vulnerable to experiencing increases in anxiety, depression, and psychomotor symptoms following TBI. A TBI may be perceived as an additional negative experience and subsequently lower wellbeing and quality of life.

5.4.8 Socio-economic Status (SES)

The hypothesis, *participants with lower socioeconomic status will score more highly on the HADS factors*, was supported by the cross-sectional sample analyses. Overall, TBI participants in the lower SES group scored significantly higher on the HADS factors than TBI participants in the other groups. TBI participants in the lower SES group reported significantly higher anxiety scores than TBI participants in the upper SES group, at the 1-month, 3-month, 6-month, and 12-month follow-ups. TBI participants with lower SES reported significantly higher anxiety scores than TBI participants in the middle SES group at the 3-month and 6-month follow-ups.

TBI participants with lower SES reported significantly higher depression and psychomotor scores at 6 months and 12 months, and showed a trend for significantly higher psychomotor scores at 3 months, when compared with TBI participants in the middle SES group. There were trends for TBI participants with lower SES to report higher depression and psychomotor scores than TBI participants in the upper SES group at the 12-month follow-up.

The findings from the analyses of SES status indicated small effect sizes for TBI patients employed in semi-skilled or unskilled roles to have higher levels of anxiety, depression, and psychomotor symptoms than TBI patients in the other SES groups (employed in professional/managerial/associate professional/skilled roles). These findings provide an

important contribution to TBI research, as studies tend not to focus on the relationship between mood and SES following head injury. Differences in mood amongst SES classes may be due to lack of flexibility in returning to work and in delegation of work, for those in less skilled occupations (Bennett & Raymond, 1997). In the present study, the greatest effect size occurred at 3 months, where TBI patients with lower SES had significantly higher anxiety scores than patients in the middle and upper SES groups. This suggests that 3 months post-injury is a pivotal point at which a TBI patient with lower SES is more at risk of experiencing symptoms of anxiety.

5.4.9 Cognitive Reserve

The findings relating to pre-morbid IQ, employment status, and SES may be explained by a cognitive reserve theory (Kesler, Adams, Blasey, & Bigley, 2003; Levi, Rassovsky, Agranov, Sela-Kaufman, & Vakil, 2013; Schneider et al., 2014). This theory suggests that pre-injury factors may act as markers of preserved functional capacity following brain injury. Individuals with higher intelligence, higher SES, and those who are in employment may have more intact functional capacity post-TBI, due to variables such as greater adaptive coping and access to resources in social, health, and educational domains (Kesler et al., 2003; Levi et al., 2013). Employment and engaging in social and recreational activities may have a facilitative affect on one's sense of purpose following brain injury (Brown, Gordon, & Spielman, 2003; Carroll & Coetzer, 2011).

5.4.10 Longitudinal Sample

In the ANOVAs performed in Study 1, the cross-sectional sample analyses had greater power and tended to show larger and more significant differences between the groups. The longitudinal sample analyses tended to support the cross-sectional sample findings, albeit with lower power.

Although the longitudinal sample analyses did not provide any statistically significant results to support the hypotheses, visual inspection of the mean plots indicated a number of similar patterns in mean scores when compared to the cross-sectional analyses. Consistent with the cross-sectional findings, in the longitudinal sample, females showed higher anxiety scores than males, participants aged 41–59 years tended to have the highest HADS and participants aged 60 years + the lowest HADS scores compared with other ages, participants with higher estimated pre-morbid intelligence tended to have greater anxiety and psychomotor scores than participants with lower estimated pre-morbid intelligence, unemployed participants showed higher HADS scores than employed participants, and participants in the lowest SES group showed the highest anxiety scores compared to participants in the other SES groups. There was a trend for an interaction between age and gender in anxiety scores, suggesting a medium effect for females aged 41–59 years to have the highest anxiety scores.

There were some differences in the findings of the longitudinal sample analyses when compared to the cross-sectional analyses. Of note, participants aged 60 yrs + displayed the highest depression scores across the follow-ups; participants with higher estimated pre-morbid intelligence had greater mean depression scores than participants with lower estimated pre-morbid intelligence at 1 month, 3 months, 6 months, and 12 months; and the highest SES group tended to show the highest depression and psychomotor scores at the later follow-ups (6, 12, and 24 months).

5.4.11 Normative Data

To determine whether TBI participants experienced greater mood disturbance than a non-clinical population, participants' mean scores on each HADS factor were compared with the related normative HADS score (Dunbar et al., 2000). Visual inspection of the mean HADS scores indicated some large differences when compared with the mean HADS scores

reported by Dunbar et al. (2000) normative sample. Female participants, participants in the 26–49 year age group and participants with below average estimated pre-morbid IQ tended to report higher HADS scores than the normative data.

5.4.12 Correlations

As expected, the results indicated there were strong relationships between each of the HADS Anxiety, Depression, and Psychomotor factors. Highly significant medium size correlations in a negative direction were found between the 1-month HADS Anxiety factor and participants' est. pre-morbid IQ at 3 and 6 months, and between the 1-month HADS Depression factor and 1-month NART FSIQ at 3 months. Small correlations were found between the HADS factors and age, which may be due to a curvilinear relationship between age and mood (see Section 5.4.4).

There was a medium strength positive relationship between participants' age and est. pre-morbid IQ, meaning the older the patient, the higher their est. pre-morbid IQ. While not all research has shown this, correlations between age and Full Scale IQ (FSIQ) have sometimes been identified. For example, Crawford, Stewart, Parker, Besson, and Cochrane (1989) found that the inclusion of age significantly improved their multiple regression equation for predicting Wechsler Adult Intelligence Scale FSIQ from NART and demographic variables.

5.4.13 Multiple Regression Analyses

Using initial demographic variables to predict HADS scores. For the Anxiety factor, the best regression models were found to predict participants' anxiety scores at 3 months (with est. pre-morbid IQ and gender accounting for 7% of the variance) and 6 months (with est. pre-morbid IQ and gender explaining 9% of the variance). The best regression models for the Depression factor were found to predict participants' depression scores at 3 months (with est. pre-morbid IQ, age, and relationship status, accounting for 12% of the variance) and 6

months (with age and est. pre-morbid IQ explaining 11% of the variance). For the Psychomotor factor, the best regression model was found for predicting participants' psychomotor scores at 3 months post-injury, with est. pre-morbid IQ, relationship status, and age, explaining 10% of the variance in psychomotor scores.

Using 1-month demographic variables to predict HADS scores. For the Anxiety factor, the best regression models were found for predicting participants' anxiety scores at 3 months and 6 months post-injury, with est. pre-morbid IQ and gender providing the best prediction of anxiety scores at these follow-ups (13% and 14% of the variance, respectively). The best regression models for the Depression factor were found for predicting participants' depression scores at 3 months (with est. pre-morbid IQ and age, explained 17% of the variance) and 6 months (with age, est. pre-morbid IQ and gender explaining 14% of the variance). For the Psychomotor factor, the best regression model was found for predicting participants' psychomotor scores at 3 months, with est. pre-morbid IQ, age, and relationship status, explaining 16% of the variance in psychomotor scores.

Overall, the findings from the multiple regression analyses performed in Study 1 are valuable and indicate a number of demographic variables are useful in predicting TBI participants' emotional outcome after their injury. These demographic variables may be useful when combined with other types of variables, some of which will be considered in the next studies of this thesis.

5.4.14 Limitations

The small effect sizes in the present research should be acknowledged and may suggest some of the findings were statistically significant due to large sample sizes rather than meaningful differences in groups. Greater weight should be placed upon the findings where larger effect sizes were noted. Some different patterns of recovery on the HADS were found between the longitudinal and cross-sectional sample analyses. This may be accounted for by

the different characteristics of these samples (Langley et al., 2010). For example, participants who attended each follow-up tended to have slightly higher mean and median ages and a reduced length of PTA, when compared to participants who did not attend each follow-up. Although the findings indicate some large differences between the present study and the normative sample in terms of the mean HADS scores reported, these findings should be interpreted with caution due to differences in the age ranges of the samples. The Dunbar et al. (2000) normative sample reported findings from three very strict age ranges (18–19 years; 39–40 years; 58–59 years), whereas the present study utilised a much broader age range.

The limitations above also apply to the subsequent studies presented in this thesis. For a more in-depth discussion of the limitations of the present research see Chapter 9.

5.5 Summary of Findings From Study 1

The present research examined the influence of demographic variables on the emotional outcome of TBI patients over a 2-year post-injury period. The descriptive statistics indicate both the cross-sectional and longitudinal samples are representative samples of the TBI clinical group, which gives weight to the findings from the present research. TBI patients showed recovery from mood problems over a 2-year time period following TBI, with lower levels of symptoms reported at 2 years following injury. Across the 2-year period, participants HADS depression scores generally remained higher than the mean normative scores provided by Dunbar (et al. 2001). Participants' HADS anxiety and psychomotor scores tended to be comparatively higher than the normative sample at the earlier follow-ups, with small mean differences at the later follow-ups.

Participants differed in their emotional outcome based upon the demographic variables examined. Higher scores on the HADS were shown by: females, patients aged 41–59 years, patients with lower pre-morbid intelligence, patients not in a significant relationship, unemployed patients, and patients with lower SES. Although many of the effect sizes were

small, considerable sized effects were found for differences in HADS scores at particular follow-up assessments—depending on the variable measured.

The results from the multiple regression analyses indicated some of the variables tended to provide statistically significant unique contributions to the regression models, predicting participants HADS scores, including NART FSIQ, age, and gender. A later study (Study 4) will examine whether these demographic risk factors can be used in combination with clinical and psychological/physiological variables, to significantly predict TBI patients' HADS factor scores at a number of follow-up assessments following TBI.

Chapter 6

Study 2 - Relationship Between Clinical Variables and Mood

As discussed in Chapter 2, a number of clinical variables have been suggested to influence mood outcome following TBI. Study 2 aimed to examine differences in TBI participants' scores on the HADS based on the clinical variables: hospitalisation, severity, orthopaedic injury, and cause of injury.

6.1 Hypotheses

1) *Hospitalisation:* Hospitalised TBI patients will exhibit higher HADS factor scores than non-hospitalised TBI patients (Chapter 2 – Section 2.2.3).
2) *Severity:* TBI patients with more severe PTA will score more highly on the HADS factors (Chapter 2 – Section 2.2.1).
3) *Orthopaedic injury:* TBI patients with greater orthopaedic injury would score more highly on the HADS factors (Chapter 2 – Section 2.2.3).
4) *Cause of injury:* Those TBI patients whose primary cause of injury was an assault or motor vehicle accident will display higher scores on the HADS factors (Chapter 2 – Section 2.2.2).
5) *Multiple regression:* Multiple regression will be performed to identify which clinical variables measured at the initial and 1-month follow-up will significantly predict the HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI (Chapter 2 – Section 2.4).

6.2 Method

6.2.1 Participants. The total sample for Study 2 consisted of 1,044 participants (aged 16–91 years) who completed the HADS following a TBI (see Chapter 5 – Section 5.2.1 for more information). Due to missing data at each follow-up assessment, the number of participants varied in the analyses (N = 197–601; see Figure 6.1).

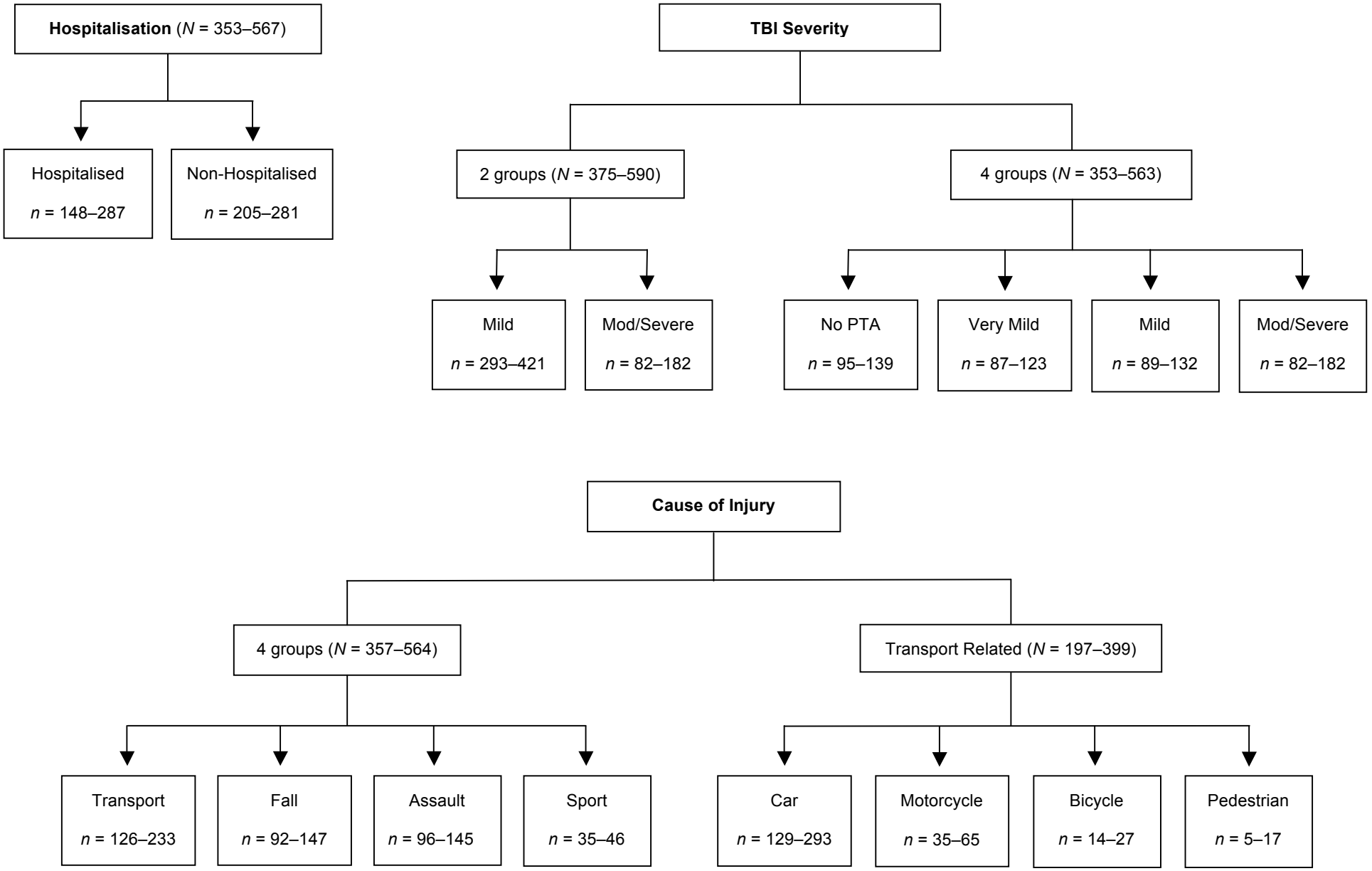

Figure 6.1. Participant numbers for the cross-sectional sample analyses reported in Study 2.

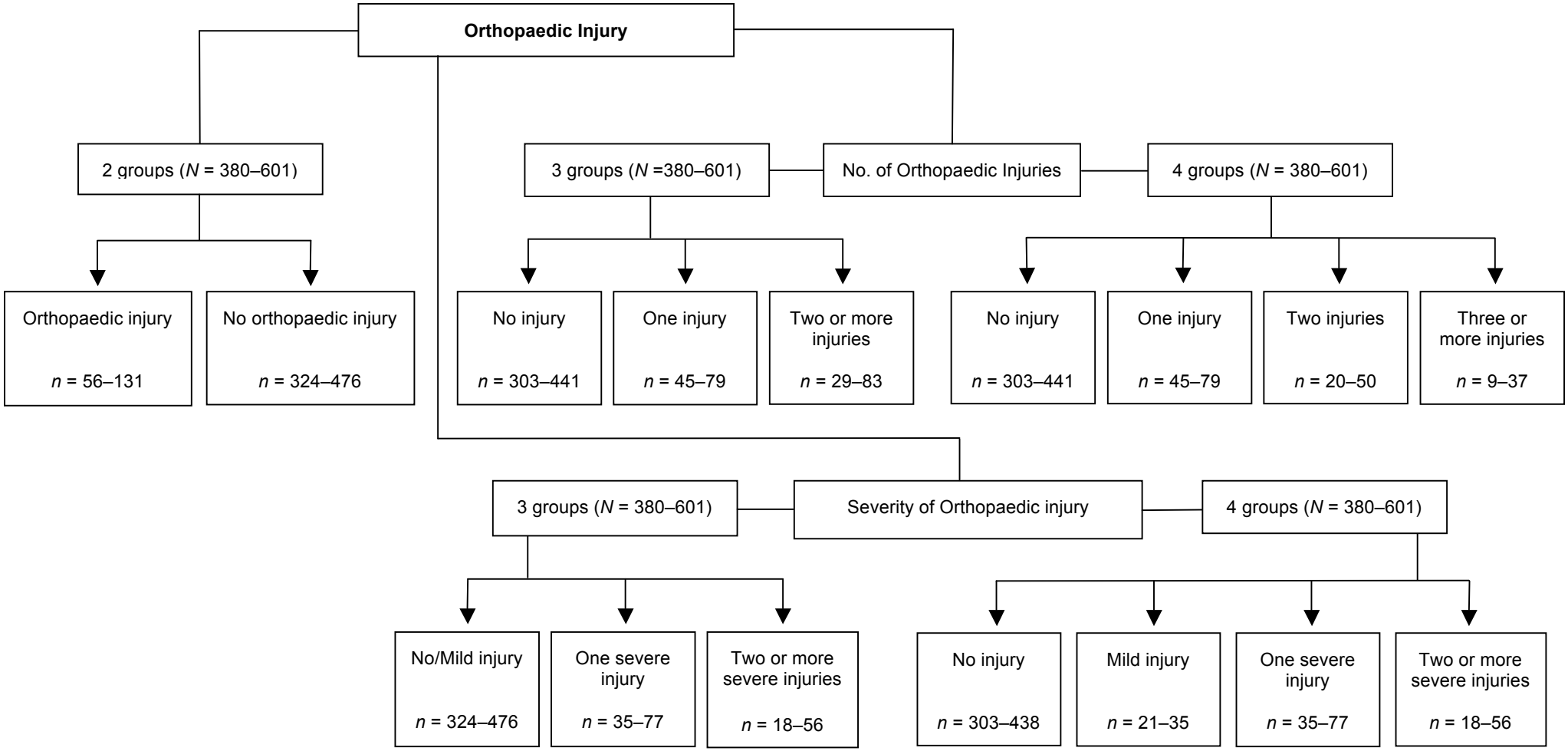

Figure 6.1. Continued.

6.2.2 Materials. For screening purposes, participants were administered the Galveston Orientation and Amnesia Test (GOAT; Levin et al., 1979). The Westmead PTA Scale (Shores et al., 1986) was used as an objective measure of the length of participants' PTA. At each follow-up assessment participants completed the Neuro Trauma assessment, a battery of neuropsychological tests and questionnaires, which included the HADS (Zigmond & Snaith, 1983). Information on cause of injury and hospitalisation was obtained from the participants' RHH Medical Records.

6.2.3 Procedure. The procedure was identical to Study 1. Participants attended a number of follow-up assessments following their head injury: the initial (baseline) assessment and further assessments at 1 month, 3 months, 6 months, 12 months, and 24 months post-injury. At each assessment participants completed the Neuro Trauma assessment battery, which included the HADS.

6.2.4 Design. A mixed between and within subjects (longitudinal) design, and a between-subjects (cross-sectional) design was employed. The between-subjects independent variables were hospitalisation, PTA, cause of injury, and orthopaedic injury. The within-subjects independent variable was time since TBI. The Anxiety, Depression, and Psychomotor HADS raw factor scores were the dependent variables.

A multiple regression design was also employed to examine whether clinical variables at the initial and 1-month follow-up assessments could be used to predict mood outcome at the 3-, 6-, 12-, and 24-month follow-ups. As the multiple regression analyses in the present study were exploratory, different variants of the variables were included in the analyses (e.g., hospitalisation days and hospitalisation 2 groups). The independent variables (predictor variables) are listed below. The HADS Anxiety, Depression, and Psychomotor raw factor scores were the dependent variables (outcome variables).

Clinical Predictor Variables:

- Hospitalisation (days)
- Hospitalisation (2 groups: hospitalised; non-hospitalised)
- Orthopaedic injury (2 groups: no orthopaedic injury; orthopaedic injury)
- Number of orthopaedic injures (3 groups: no orthopaedic injury; one injury; two + injuries)
- Number of orthopaedic injures (4 groups: no orthopaedic injury; one injury; two injuries; three injuries +)
- Severity of orthopaedic injures (3 groups: no/mild; one severe injury; two + severe injuries)
- Severity of orthopaedic injures (4 groups: no orthopaedic injury; mild; one severe injury; two + severe injuries)
- PTA (days: 0–60)
- PTA (2 groups: mild; mod/severe)
- PTA (3 groups: no PTA; < 1hr; > 1hr)
- PTA (4 groups: no PTA; <1hr; >1hr & < 1day; > 1day)
- Cause of injury (4 groups: transport, assault, fall, sport)
- Transport-related cause of injury (4 groups: car, motorcycle, bicycle, pedestrian)

6.2.5 Data analysis. Data screening and analysis was identical to Study 1. Two types of analyses were conducted to compare groups' HADS scores using IBM SPSS Statistics version 20.0**:** *Longitudinal Sample* (*N* = 90–101; repeated measures analysis of variance [ANOVAs] on the data of the participants who came to every follow-up), to assess change/recovery in mood over 24 months post-TBI; *Cross-sectional Sample* (*N* = 197–601; independent samples *t*-tests/one-way ANOVAS on the data of all participants attending a

specific follow-up point [e.g., initial assessment]). The analyses were performed using the independent variables of PTA, cause of injury, hospitalisation, and orthopaedic injury, the HADS factor scores as dependant variables, and the time periods post-injury (repeated measures).

The assumptions were tested for each of the statistical analyses in the same manner as Study 1 (see Chapter 5). To examine the relationship between the predictor variables and the dependent variables, preliminary regression analyses involved entering all predictor variables into the equation. Stepwise regression was then conducted where variables were selected based upon mathematical criteria (Tabachnick & Fidell, 2000). Probability of .15 for entry was chosen (Bendel & Afifi, 1977 cited in Tabachnick & Fidell, 2000).

6.3 Results

6.3.1 Descriptive Statistics

Table 6.1 displays means, medians, standard deviations, percentages, and ranges for the clinical variables in the cross-sectional (i.e., total sample – participants who were found to have a HADS score at one of the assessments) and longitudinal samples. As shown in Table 6.1, similar descriptive statistics were found for both samples, with the main difference being a greater percentage of mild TBI participants in the longitudinal (81%) compared with the cross-sectional (72%) sample. Overall, the descriptive statistics were consistent with previous findings from TBI epidemiology studies (Tate et al., 1998; O'Connor, 2003), with the majority of participants sustaining a mild TBI, and high rates of transport-related accidents, assaults, and falls.

Table 6.1

Descriptive Statistics for Clinical Variables

Characteristic	*Mdn*/%	*M*	*SD*	Range
Cross-sectional Sample				
PTA (days)	.04	2.20	6.69	0–60
PTA - Mild	72%			
Length of Hospitalisation	.13	2.26	8.04	0–104
Hospitalised	41%			
Orthopaedic Injury	18%			
Transport related	34%			
- *Car*	73%			
- *Motorcycle*	16%			
- *Bicycle*	7%			
- *Pedestrian*	4%			
Assault	24%			
Fall	30%			
Sporting Injury	12%			
Longitudinal Sample				
PTA (days)	.03	.46	.94	0–5
PTA - Mild	81%			
Length of Hospitalisation	.12	3.01	11.55	0–104
Hospitalised	39%			
Orthopaedic Injury	23%			
Transport related	37%			
Assault	31%			
Fall	23%			
Sporting Injury	9%			

6.3.2 Hospitalisation

Cross-Sectional Sample. Independent samples *t*-tests were conducted at each follow-up to compare participants' HADS scores based on their level of hospitalisation (Table 6.3). Two groups were included in the analyses, the hospitalised group and the non-hospitalised group. Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 449 to 568 participants (see Figure 6.1). Table 6.2 displays the mean HADS scores and standard deviations from these analyses. The mean scores were plotted over time for the Anxiety factor (Figure 6.2), Depression factor, and Psychomotor factor (Figures C1 and C2 – Appendix C).

Table 6.2

Descriptive Statistics for Hospitalisation on the HADS Factors – Cross-Sectional Sample

HADS Factor/Group		Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety							
Hospitalised	*M*	2.77	2.54	2.55	2.34	2.49	2.60
	SD	(2.30)	(2.32)	(2.43)	(2.42)	(2.51)	(2.38)
Non-Hospitalised	*M*	3.50	2.92	2.68	2.50	2.40	2.50
	SD	(2.68)	(2.36)	(2.50)	(2.43)	(2.46)	(2.51)
Depression							
Hospitalised	*M*	1.45	1.49	1.41	1.34	1.52	1.49
	SD	(1.53)	(1.78)	(1.71)	(1.70)	(1.83)	(1.72)
Non-Hospitalised	*M*	1.72	1.47	1.32	1.31	1.24	1.18
	SD	(1.85)	(1.73)	(1.71)	(1.74)	(1.76)	(1.85)
Psychomotor							
Hospitalised	*M*	3.76	3.41	3.18	3.08	3.14	3.14
	SD	(2.28)	(2.39)	(2.20)	(2.40)	(2.29)	(2.23)
Non-Hospitalised	*M*	3.96	3.43	3.12	3.00	2.77	2.78
	SD	(2.27)	(2.44)	(2.30)	(2.25)	(2.33)	(2.36)

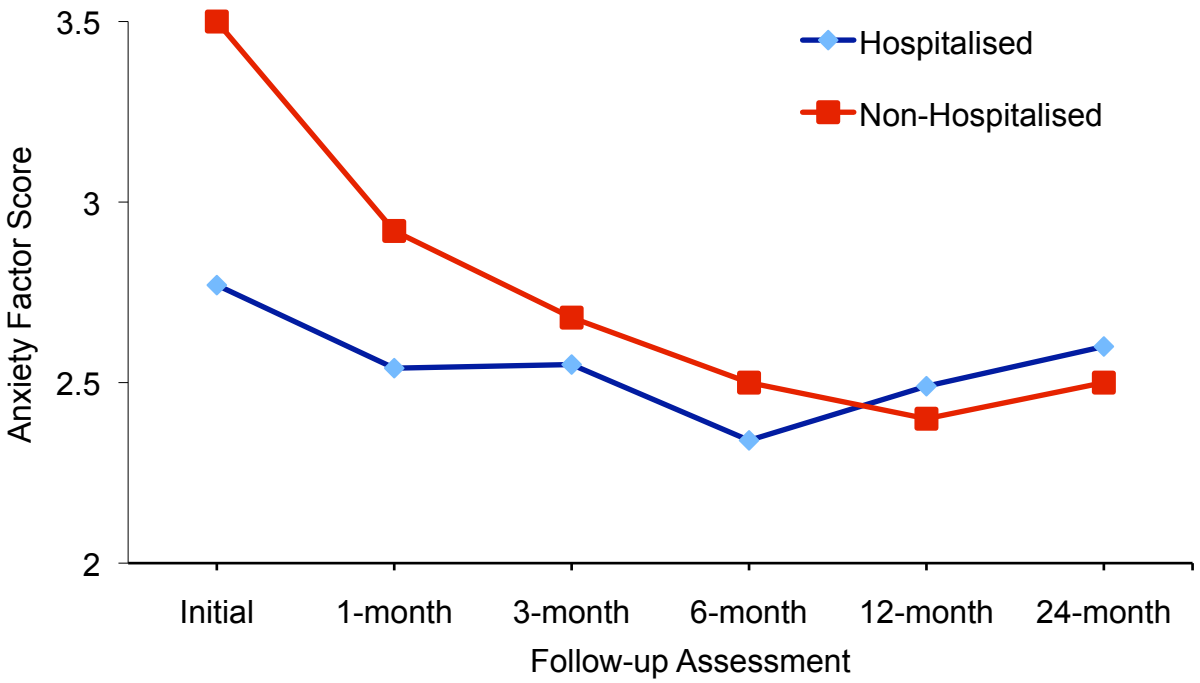

Figure 6.2. Mean anxiety factor scores over time for hospitalisation (cross-sectional sample).

Anxiety factor. The non-hospitalised group showed a higher mean score than the hospitalised group at the initial follow-up (p = .002; Figure 6.2; Table 6.3), with Cohen's d indicating a small effect size. No significant differences were found at the other follow-ups.

Depression factor. Similar to the Anxiety factor findings, there was a trend for the non-hospitalised group to show a higher mean score than the hospitalised group at the initial follow-up (p = .085; Figure C1 – Appendix C; Table 6.3). There was a trend for the hospitalised group to report higher mean depression scores than the non-hospitalised group at the 12-month (p = .079) and 24-month follow-ups (p = .062). Cohen's d indicated small effect sizes. No significant differences were found at the other follow-ups.

Psychomotor factor. There was a trend for the hospitalised group to show a higher mean score than the non-hospitalised group at the 12-month follow-up (p = .080), with a small effect size (Figure C2 – Appendix C; Table 6.3). No significant differences were found at the other follow-ups.

Table 6.3

Independent Samples t-Tests for Hospitalisation on the HADS factors

Follow-up/ HADS Factor	*t*	*df*	*p*	Cohen's *d*	Power	Mean Difference	95% CI LL	95% CI UL
Initial (<15 days)								
Anxiety	3.12**	437	.002	.30	.86	.73	.27	1.19
Depression	1.72	444	.085	.16	.39	.27	-.04	.58
Psychomotor	.95	461	.340	.09	.16	.21	-.22	.63
1-month								
Anxiety	1.51	351	.131	.16	.32	.38	-.11	.88
Depression	-.13	351	.899	-.01	.05	-.02	-.39	.35
Psychomotor	.08	351	.937	.01	.05	.02	-.49	.53
3-month								
Anxiety	.62	565	.537	.05	.09	.13	-.28	.53
Depression	-.65	565	.518	-.05	.09	-.09	-.37	.19
Psychomotor	-.35	565	.724	-.03	.06	-.07	-.44	.30
6-month								
Anxiety	.77	566	.439	.06	.11	.16	-.24	.56
Depression	-.25	566	.803	-.02	.06	-.04	-.32	.25
Psychomotor	-.43	566	.666	-.04	.08	-.08	-.47	.30
12-month								
Anxiety	-.41	485	.685	-.04	.07	-.09	-.54	.35
Depression	-1.76	485	.079	-.16	.42	-.29	-.61	.03
Psychomotor	-1.76	485	.080	-.16	.42	-.37	-.78	.04
24-month								
Anxiety	-.43	447	.666	-.04	.07	-.10	-.55	.35
Depression	-1.87	447	.062	-.18	.48	-.32	-.65	.02
Psychomotor	-1.63	447	.105	-.15	.35	-.35	-.78	.07

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' level of hospitalisation on HADS scores across six time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 90 participants who came to every follow-up assessment and completed the HADS. The sample consisted of two groups: hospitalised (n = 35) and non-hospitalised (n = 55). Mean HADS scores and standard deviations are shown in Table 6.4.

Table 6.4

Descriptive Statistics for Hospitalisation on the HADS Factors – Longitudinal Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Hospitalised	2.27	1.65	1.66	1.59	1.37	1.91
	(1.66)	(1.69)	(1.80)	(1.48)	(1.39)	(1.79)
Non-Hospitalised	2.43	2.28	2.04	1.76	1.98	1.94
	(2.36)	(2.22)	(2.09)	(2.01)	(2.28)	(2.03)
Depression						
Hospitalised	1.35	1.39	1.13	.99	.92	.86
	(1.41)	(1.60)	(1.33)	(1.41)	(1.35)	(1.32)
Non-Hospitalised	1.59	1.12	.91	.85	.89	.85
	(1.90)	(1.48)	(1.51)	(1.25)	(1.35)	(1.49)
Psychomotor						
Hospitalised	3.37	3.04	2.79	2.36	2.17	2.19
	(1.88)	(2.19)	(2.06)	(1.72)	(1.66)	(1.72)
Non-Hospitalised	3.26	2.75	2.48	2.35	2.37	2.29
	(2.07)	(2.47)	(2.17)	(1.87)	(2.32)	(2.01)

Note. Mean values are displayed with standard deviations presented in parentheses.

Table 6.5 shows the tests of within-subjects effects for hospitalisation on the HADS factors. There was a main effect for time since TBI on the Anxiety factor, $F(4, 350) = 4.29$, $p = .002$, $\eta^2_{partial} = .05$; Depression factor, $F(4, 333) = 5.02$, $p = .001$, $\eta^2_{partial} = .05$; and the Psychomotor factor, $F(4, 387) = 9.32$, $p < .001$, $\eta^2_{partial} = .10$. These results indicate a significant reduction in participants' mean HADS scores over time. Small effect sizes were found for the main effect of time on the Anxiety and Depression factors and a medium effect size for the Psychomotor factor.

Bonferroni post-hoc comparisons for time, for each of the HADS factors are displayed in 'Output – Study 2' (Appendix C on the CD). Table C1 (Appendix C) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. Significant differences in mean anxiety scores were found between the initial and 6-month follow-up ($p = .003$), and the initial and 12-month follow-up ($p = .006$). There was a trend for a difference in mean anxiety scores between the initial and 3-month follow-up ($p = .074$). A significant difference in mean depression scores was found between the initial and 24-month follow-up ($p = .034$). There were trends for differences in mean depression scores between: the initial and 6-month follow-up ($p = .055$), the initial and 12-month follow-up ($p = .073$), and the 1-month and 12-month follow-up ($p = .071$). Significant differences in mean psychomotor scores were found between the initial follow-up and: the 3-month ($p = .047$), 6-month ($p < .001$), 12-month ($p < .001$), and 24-month ($p < .001$) follow-ups. Significant differences in mean psychomotor scores were found between the 1-month and 12-month follow-up ($p = .009$), and the 1-month and 24-month follow-up ($p = .048$). There was a strong trend for a difference in mean psychomotor scores between the 1-month and 6-month follow-up ($p = .052$).

Tests of between-subjects effects for hospitalisation on the HADS factors are displayed in Table 6.5. The main effect comparing the two hospitalisation groups was not significant

for the Anxiety factor, $F(1, 88) = .82$, $p = .367$, $\eta^2_{partial} = .01$; Depression factor, $F(1, 88) = .08$, $p = .779$, $\eta^2_{partial} = .00$; and the Psychomotor factor, $F(1, 88) = .04$, $p = .852$, $\eta^2_{partial} = .00$, indicating there were no differences between the mean HADS scores of the groups. The Time x Hospitalisation interaction was non-significant for the Anxiety factor, $F(4, 350) = 1.08$, $p = .365$, $\eta^2_{partial} = .01$; the Depression factor, $F(4, 333) = .70$, $p = .583$, $\eta^2_{partial} = .01$; and the Psychomotor factor, $F(4, 387) = .55$, $p = .714$, $\eta^2_{partial} = .01$.

Table 6.5

Tests of Within-Subjects & Between-Subjects Effects for Hospitalisation on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	350	4.29**	.002	.05	.93
Hospitalisation	1	88	.82	.367	.01	.15
Time x Hosp[a]	4	350	1.08	.365	.01	.34
Depression						
Time since TBI[a]	4	333	5.02***	.001	.05	.96
Hospitalisation	1	88	.08	.779	.00	.06
Time x Hosp[a]	4	333	.70	.583	.01	.22
Psychomotor						
Time since TBI[a]	4	387	9.32***	< .001	.10	1.00
Hospitalisation	1	88	.04	.852	.00	.05
Time x Hosp[a]	4	387	.55	.714	.01	.19

Note. [a]Greenhouse Geisser results are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

6.3.3 Severity

Cross-sectional sample (two groups). Independent samples *t*-tests (Table 6.7) were conducted at each follow-up to compare participants' HADS scores based on severity of TBI (measured by PTA level). Two groups were included in the analyses, the mild PTA group and the moderate/severe PTA group. Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 375 to 590 participants (see Figure 6.1). Table 6.6 displays the mean HADS scores and standard deviations from these analyses. The mean scores were plotted over time for the Anxiety factor (Figure C3 – Appendix C), Depression factor (Figure C4 – Appendix C), and Psychomotor factor (Figure 6.3).

Table 6.6

Descriptive Statistics for PTA on the HADS Factors – Cross Sectional Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Mild PTA	3.10	2.63	2.56	2.33	2.27	2.40
	(2.55)	(2.27)	(2.44)	(2.37)	(2.35)	(2.31)
Mod/Severe PTA	3.65	3.19	2.74	2.66	2.78	2.88
	(2.48)	(2.66)	(2.52)	(2.56)	(2.68)	(2.58)
Depression						
Mild PTA	1.53	1.31	1.27	1.22	1.18	1.23
	(1.71)	(1.65)	(1.62)	(1.68)	(1.66)	(1.74)
Mod/Severe PTA	2.08	2.06	1.53	1.55	1.81	1.63
	(1.92)	(2.02)	(1.83)	(1.72)	(1.93)	(1.89)
Psychomotor						
Mild PTA	3.77	3.28	3.08	2.91	2.72	2.76
	(2.26)	(2.39)	(2.22)	(2.26)	(2.20)	(2.18)
Mod/Severe PTA	4.49	3.97	3.28	3.29	3.43	3.44
	(2.38)	(2.58)	(2.26)	(2.35)	(2.46)	(2.51)

Note. Mean values are displayed with standard deviations presented in parentheses.

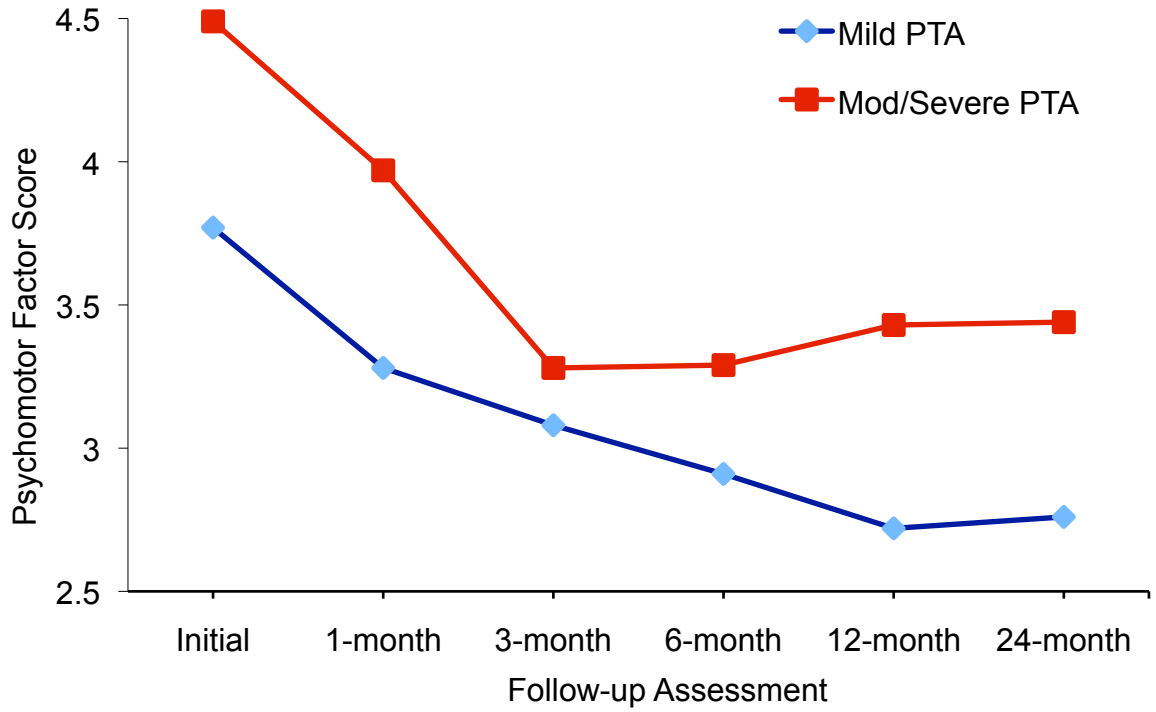

Figure 6.3. Mean psychomotor factor scores for PTA (cross-sectional sample).

Anxiety factor. On the Anxiety factor (Figure C3 – Appendix C; Table 6.7), the moderate/severe PTA group showed significantly higher mean scores than the mild PTA group at the 12-month (p = .042) and 24-month follow-ups (p = .041). There was a strong trend for the moderate/severe PTA group to have higher mean anxiety scores than the mild PTA group at the initial (p = .063) and 1-month follow-ups (p = .060). No significant differences in mean anxiety scores were found at the other follow-ups. Cohen's d indicated small effect sizes.

Depression factor. On the Depression factor (Figure C4 – Appendix C; Table 6.7), the moderate/severe PTA group showed significantly higher mean scores than the mild PTA group at the initial (p = .007), 1-month (p = .003), 6-month (p = .027), 12-month (p = .001), and 24-month (p = .021) follow-ups. There was a trend for the moderate/severe PTA group to report a higher mean depression score than the mild PTA group at the 3-month follow-up (p = .097). Cohen's d showed a medium effect size at 1-month and small effect sizes at the other follow-ups.

Psychomotor factor. On the Psychomotor factor (see Figure 6.3; Table 6.7), the moderate/severe PTA group showed significantly higher mean scores than the mild PTA group at the initial (p = .006), 1-month (p = .023), 12-month (p = .002), and 24-month (p = .004) follow-ups. There was a trend for the moderate/severe PTA group to have a higher mean psychomotor score at the 6-month follow-up (p = .063). Cohen's d indicated small effect sizes.

Table 6.7

Independent Samples t-Tests for PTA – Cross-Sectional Sample

Follow-up/ HADS Factor	*t*	*df*	*p*	Cohen's *d*	Power	Mean Difference	95% CI LL	95% CI UL
Initial (<15 days)								
Anxiety	-1.86	479	.063	-.17	.31	-.55	-1.13	.03
Depression	-2.69**	479	.007	-.25	.57	-.15	-.95	-.15
Psychomotor	-2.74**	479	.006	-.25	.57	-.73	-1.25	-.21
1-month								
Anxiety	-1.89	373	.060	-.20	.36	-.56	-1.14	.02
Depression	-3.06**	113	.003	-.58	1.00	-.74	-1.23	-.26
Psychomotor	-2.28*	373	.023	-.24	.48	-.69	-1.29	-.10
3-month								
Anxiety	-.81	588	.421	-.07	.12	-.18	-.62	.26
Depression	-1.67	588	.097	-.14	.34	-.26	-.56	.05
Psychomotor	-.98	588	.328	-.08	.14	-.20	-.60	.20
6-month								
Anxiety	-1.53	587	.126	-.13	.31	-.33	-.76	.09
Depression	-2.22*	587	.027	-.18	.52	-.33	-.63	-.04
Psychomotor	-1.87	587	.063	-.15	.39	-.38	-.78	.02
12-month								
Anxiety	-2.04*	260	.042	-.25	.73	-.51	-1.00	-.02
Depression	-3.53***	256	.001	-.44	1.00	-.63	-.98	-.28
Psychomotor	-3.11**	264	.002	-.38	.98	-.72	-1.17	-.26
24-month								
Anxiety	-2.05*	474	.041	-.19	.49	-.48	-.94	-.02
Depression	-2.32*	474	.021	-.21	.57	-.41	-.75	-.06
Psychomotor	-2.91**	267	.004	-.36	.96	-.69	-1.15	-.22

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Cross-sectional sample (four groups). Following a frequency analysis, the most exhaustive way of analysing the data while keeping adequate cell sizes, was to split the sample into four groups: no PTA, very mild (<1hr PTA), mild (>1hr & <1day PTA), and moderate/severe (>1day PTA). One-way between subjects ANOVAS were conducted on the HADS data of the four groups at each follow-up assessment (Table 6.8). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 353 to 563 participants (see Figure 6.1). Mean HADS scores and standard deviations are shown in Table C2 (Appendix C). The mean scores are plotted for the Anxiety factor (Figure C5 – Appendix C), Depression factor (Figure 6.4), and Psychomotor factor (Figure C6 – Appendix C).

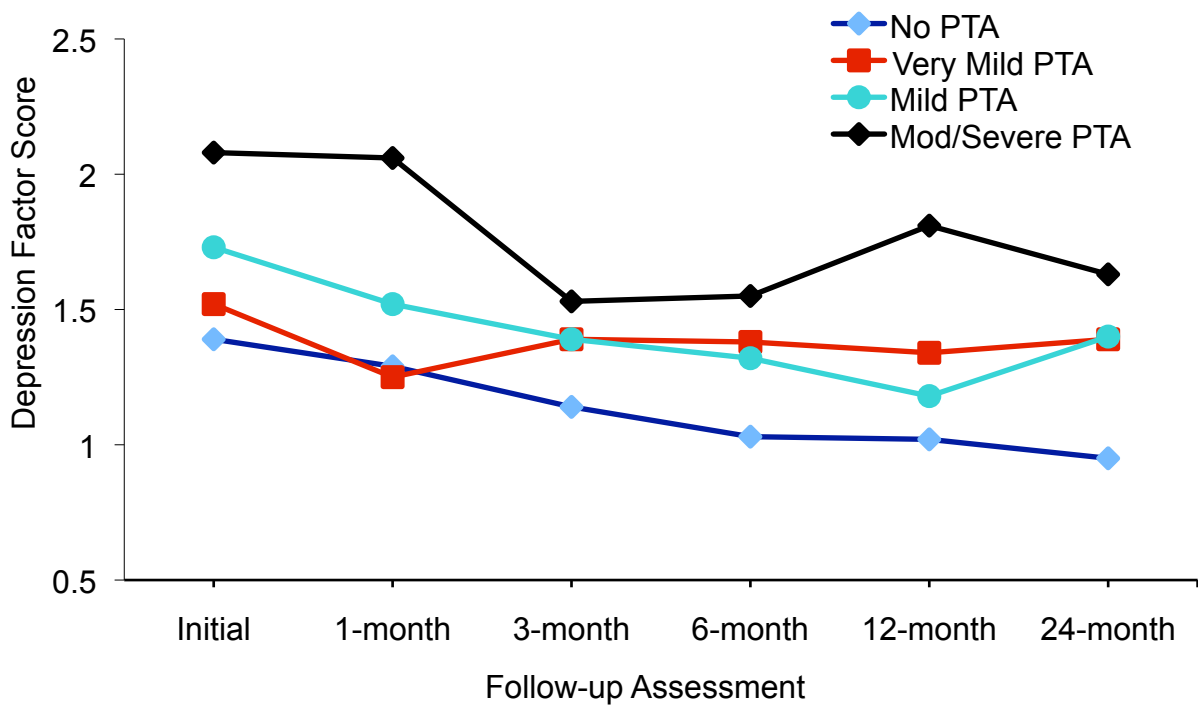

Figure 6.4. Mean depression factor scores for PTA four groups (cross-sectional sample).

Anxiety factor. On the Anxiety factor (Figure C5 – Appendix C; Table 6.8), at the 12-month follow-up there was a significant difference in the mean scores between the groups ($p < .05$), with $\eta^2_{partial}$ indicating a small effect size. Table 6.9 shows the Tukey post-hoc tests that were significant or indicated a trend for differences between the groups on each of the HADS factors (for the full table of post-hoc tests for each of the HADS factors see 'Output – Study 2' in Appendix C on the CD). The moderate/severe PTA group showed significantly higher mean anxiety scores than the no PTA group at the 12-month follow-up ($p < .05$; see Figure C5).

Depression factor. On the Depression factor (Figure 6.4; Table 6.8), significant differences in mean scores were found between the groups at the initial, 1-month, 12-month, and 24-month follow-ups ($p < .05$). There was a trend for a difference in mean depression scores at 6 months ($p = .067$). $\eta^2_{partial}$ indicated small effect sizes. Tukey post-hoc tests (Table 6.9) showed the moderate/severe PTA group reported significantly higher mean depression scores than the no PTA group at the initial ($p < .05$), 6-month ($p < .05$), 12-month ($p < .001$), and 24-month ($p < .05$) follow-ups. The mild PTA group showed significantly lower mean depression scores than the moderate/severe PTA group at 12 months (see Figure 6.4).

Psychomotor factor. On the Psychomotor factor, significant differences in mean scores were found between the groups at the initial ($p < .05$), 12-month ($p < .001$), and 24-month ($p < .05$) follow-ups (see Figure C6 – Appendix C; Table 6.8). $\eta^2_{partial}$ indicated small effect sizes. Tukey post-hoc tests (Table 6.9) showed the moderate/severe PTA group reported significantly higher mean psychomotor scores than the no PTA group at the initial ($p < .05$), 12-month ($p < .001$), and 24-month ($p < .05$) follow-ups. At the initial follow-up, there was a trend for the moderate/severe PTA group to show higher mean psychomotor scores than the very mild PTA group ($p = .072$; see Figure C6).

Table 6.8

One-way ANOVA for PTA (Four Groups) on the HADS Factors – Cross-Sectional Sample

HADS Factor/ Follow-up	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Initial (<15 days)	3	447	.86	.464	.01	.40
1-month	3	349	1.44	.231	.01	.32
3-month	3	559	1.10	.350	.01	.49
6-month	3	514	1.24	.296	.01	.49
12-month	3	451	2.77*	.041	.02	.75
24-month	3	448	2.08	.102	.01	.40
Depression						
Initial (<15 days)	3	447	3.08*	.027	.02	.72
1-month	3	349	3.77*	.011	.03	.80
3-month	3	559	1.32	.268	.01	.49
6-month	3	552	2.40	.067	.01	.49
12-month	3	451	2.77*	.041	.03	.91
24-month	3	406	3.05*	.028	.02	.72
Psychomotor						
Initial (<15 days)	3	447	3.44*	.017	.02	.72
1-month	3	349	1.70	.167	.01	.32
3-month	3	559	1.26	.287	.01	.49
6-month	3	552	1.77	.152	.01	.49
12-month	3	450	5.49***	.001	.03	.91
24-month	3	448	3.17*	.024	.02	.72

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6.9

Significant/Trend Tukey Post-hoc Tests for PTA (Four Groups) on the HADS Factors – Cross-Sectional Sample

HADS Factor/ Follow-up	PTA Comparison	*SE*	*p*
Anxiety			
12-month	No PTA & Mod/Severe	.30	.024
Depression			
Initial (<15 days)	No PTA & Mod/Severe	.24	.021
6-month	No PTA & Mod/Severe	.20	.039
12-month	No PTA & Mod/Severe	.21	.001
12-month	Mild & Mod/Severe	.22	.021
24-month	No PTA & Mod/Severe	.23	.015
Psychomotor			
Initial (<15days)	No PTA & Mod/Severe	.31	.025
Initial (<15days)	Very Mild & Mod/Severe	.32	.072
12-month	No PTA & Mod/Severe	.28	.000
24-month	No PTA & Mod/Severe	.29	.027

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' PTA level on HADS scores across six time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 101 participants who came to every follow-up assessment and completed the HADS. The sample consisted of two groups: mild PTA (n = 82) and moderate/severe PTA (n = 19). Mean HADS scores and standard deviations are shown in Table 6.10.

Table 6.10

Descriptive Statistics for PTA on the HADS Factors – Longitudinal Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Mild PTA	2.28	1.99	1.98	1.66	1.68	1.96
	(2.11)	(1.87)	(1.90)	(1.86)	(1.91)	(1.90)
Mod/Severe PTA	2.93	2.47	1.93	2.15	2.30	2.25
	(2.32)	(2.75)	(2.37)	(2.32)	(2.48)	(2.08)
Depression						
Mild PTA	1.44	1.11	1.02	.95	.96	1.00
	(1.80)	(1.51)	(1.42)	(1.38)	(1.44)	(1.69)
Mod/Severe PTA	2.25	1.84	1.07	.96	.86	.81
	(1.86)	(1.79)	(1.48)	(1.30)	(1.22)	(1.09)
Psychomotor						
Mild PTA	3.29	2.88	2.69	2.38	2.39	2.42
	(2.03)	(2.39)	(2.10)	(1.80)	(2.17)	(2.06)
Mod/Severe PTA	4.19	3.46	2.65	2.74	2.43	2.34
	(2.26)	(2.63)	(2.22)	(2.27)	(2.10)	(1.89)

Note. Mean values are displayed with standard deviations presented in parentheses.

Table 6.11 shows the tests of within-subjects effects for PTA on the HADS factors. There was a main effect for time since TBI on the Anxiety factor, $F(5, 495) = 3.22$, $p = .007$, $\eta^2_{partial} = .03$; Depression factor, $F(5, 495) = 8.15$, $p < .001$, $\eta^2_{partial} = .08$; and the Psychomotor factor, $F(5, 495) = 10.21$, $p < .001$, $\eta^2_{partial} = .09$. These results indicate a significant reduction in participants' mean HADS scores over time. For the main effect of time, a small effect size was found on the Anxiety factor, and medium effect sizes on the Depression and Psychomotor factors.

Tests of between-subjects effects for PTA on the HADS factors are displayed in Table 6.11. The main effect comparing the two PTA groups was not significant for the Anxiety factor, $F(1, 99) = .88$, $p = .350$, $\eta^2_{partial} = .01$; Depression factor, $F(1, 99) = .53$, $p = .468$, $\eta^2_{partial} = .01$; and the Psychomotor factor, $F(1, 99) = .43$, $p = .514$, $\eta^2_{partial} = .00$. This indicates there were no significant differences between the mean scores of the groups.

The Time x PTA interaction was non-significant for the Anxiety factor, $F(5, 495) = .82$, $p = .350$, $\eta^2_{partial} = .01$; and the Psychomotor factor, $F(5, 495) = 1.41$, $p = .221$, $\eta^2_{partial} = .01$. When adopting a more stringent alpha level ($p < .01$), there was a trend for a Time x PTA interaction on the Depression factor, $F(5, 495) = 2.59$, $p = .025$, $\eta^2_{partial} = .03$, with a small effect size. This indicates that from the 1-month to 3-month follow-up, the moderate/severe PTA group showed a reduction in mean depression scores, while there was little change in the mean depression scores of the mild PTA group.

Bonferroni post-hoc comparisons for time, for each of the HADS factors are displayed in 'Output – Study 2' (Appendix C on the CD). Table C3 (Appendix C) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. Significant differences in mean anxiety scores were found between the initial and 3-month follow-up ($p = .043$), and the initial and 6-month follow-up ($p = .012$). There were significant differences in mean depression scores between the initial follow-up and: the 3-month ($p = .005$), 6-month ($p = .001$), 12-month ($p = .004$), and 24-month ($p = .005$) follow-ups. Significant differences in mean depression scores were found between the 1-month and 6-month follow-up ($p = .016$), and the 1-month and 12-month follow-up ($p = .006$). Significant differences in mean psychomotor scores were found between the initial follow-up and: the 3-month ($p = .001$), 6-month ($p < .001$), 12-month ($p < .001$), and 24-month ($p < .001$) follow-ups. There were significant differences in mean psychomotor scores between the 1-month and 12-month follow-up ($p = .007$), and the 1-month and 24-month follow-up ($p = .036$).

There was a weak trend for a difference in mean psychomotor scores between the 1-month and 6-month follow-up (p = .097).

Table 6.11

Tests of Within-Subjects & Between-Subjects Effects for PTA on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	386	3.22*	.014	.03	.82
PTA	1	99	.88	.350	.01	.15
Time x PTA[a]	4	386	.81	.512	.01	.26
Depression						
Time since TBI[a]	4	362	8.15***	.000	.08	1.00
PTA	1	99	.53	.468	.01	.11
Time x PTA[a]	4	362	2.59*	.042	.03	.70
Psychomotor						
Time since TBI[a]	4	438	10.21***	< .001	.09	1.00
PTA	1	99	.43	.514	.00	.10
Time x PTA[a]	4	438	1.41	.227	.01	.46

Note. [a]Greenhouse Geisser results are reported.
*p < .05. **p < .01. ***p < .001.

PTA & Cause of injury. A one-way between-subjects ANOVA was conducted to determine whether there are differences in participants' PTA scores based on the cause of their TBI. The total sample consisted of 452 participants, who were categorized as sustaining TBI from a transport-related accident, assault, fall, or sporting accident. Table 6.12 displays the mean HADS scores and standard deviations from this analysis and Table 6.13 shows tests of between-subjects effects for cause and PTA. There was no significant difference between the cause of injury groups in their mean PTA scores, $F(3, 448) = .69$, $p = .557$, $\eta^2_{partial} = .00$.

Table 6.12

Descriptive Statistics for Cause of Injury & PTA

Dependent Variable		Transport (*n* = 165)	Fall (*n* = 108)	Assault (*n* = 141)	Sport (*n* = 38)
PTA	*M*	.60	.75	.76	.30
	SD	(1.55)	(2.03)	(2.47)	(.74)

Table 6.13

Tests of Between-Subjects Effects for Cause & PTA

Variable	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
PTA						
Between Groups	3	448	.69	.00	.557	.40

6.3.4 Orthopaedic Injury

As no previous research appears to have examined the relationship between orthopaedic damage and mood following TBI, orthopaedic injury was categorised in a range of different ways—based upon the presence, number, and severity of orthopaedic injury. Therefore, a number of cross-sectional sample analyses were performed on the data.

Two groups. Independent samples *t*-tests were conducted at each follow-up to compare participants' HADS scores based on the presence of orthopaedic injury (Table 6.15). Two groups were included in the analyses, the orthopaedic injury group and the no orthopaedic injury group. Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 380 to 601 participants (see Figure 6.1). Table 6.14 displays the mean HADS scores and standard deviations from these analyses. The mean scores were plotted over time for the Anxiety factor (Figure 6.5), Depression factor (Figure C7 – Appendix C), and Psychomotor factor (Figure C8 – Appendix C).

Table 6.14

Descriptive Statistics for Orthopaedic Injury on the HADS Factors – Cross-Sectional Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Orthopaedic injury	2.40	2.47	2.78	2.55	2.67	2.48
	(2.14)	(2.40)	(2.50)	(2.53)	(2.66)	(2.35)
No orthopaedic injury	3.33	2.79	2.56	2.39	2.36	2.55
	(2.59)	(2.37)	(2.45)	(2.41)	(2.40)	(2.41)
Depression						
Orthopaedic injury	1.30	1.35	1.51	1.57	1.57	1.48
	(1.65)	(1.72)	(1.79)	(1.81)	(1.84)	(1.67)
No orthopaedic injury	1.68	1.48	1.29	1.25	1.32	1.30
	(1.77)	(1.76)	(1.65)	(1.67)	(1.77)	(1.82)
Psychomotor						
Orthopaedic injury	3.49	3.47	3.43	3.27	3.28	3.07
	(2.19)	(2.65)	(2.29)	(2.43)	(2.41)	(2.11)
No orthopaedic injury	3.96	3.40	3.04	2.96	2.84	2.93
	(2.30)	(2.41)	(2.21)	(2.28)	(2.27)	(2.36)

Note. Mean values are displayed with standard deviations presented in parentheses.

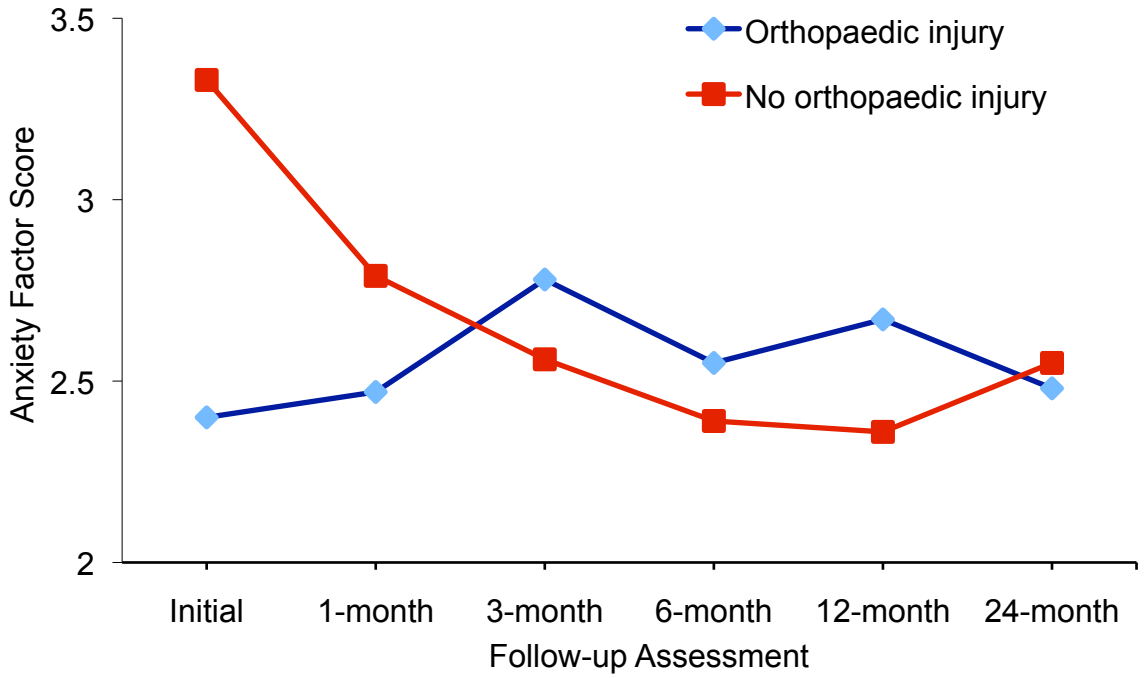

Figure 6.5. Mean anxiety factor scores over time for orthopaedic injury (cross-sectional sample).

Anxiety factor. On the Anxiety factor (Figure 6.5; Table 6.15), the no orthopaedic injury group showed a significantly higher mean score than the orthopaedic injury group ($p <$ .01) at the initial follow-up, with Cohen's *d* indicating a medium effect size. No significant differences were found between the groups at the other follow-ups.

Depression factor. On the Depression factor (Figure C7 – Appendix C; Table 6.15) there was a trend for the orthopaedic injury group to show significantly higher mean scores than the no orthopaedic injury group at the 6-month follow-up (p = .058), with a small effect size. No significant differences were found between the groups at the other follow-ups.

Psychomotor factor. On the Psychomotor factor (Figure C8 – Appendix C; Table 6.15) there were trends for the orthopaedic injury group to show significantly higher mean scores than the no orthopaedic injury group at the 3-month (p = .083) and 12-month (p = .070) follow-ups, with small effect sizes. No significant differences were found between the groups at the other follow-ups.

Table 6.15

Independent Samples t-Tests for Orthopaedic Injury on the HADS Factors – Cross-Sectional Sample

Follow-up/ HADS Factor	*t*	*df*	*p*	Cohen's *d*	Power	Mean Difference	95% CI LL	95% CI UL
Initial (<15 days)								
Anxiety	3.15**	93	.002	.65	1.00	.93	.34	1.51
Depression	1.63	491	.104	.15	.20	.38	-.08	.84
Psychomotor	1.54	491	.124	.14	.18	.47	-.13	1.08
1-month								
Anxiety	.93	75	.354	.21	.30	.32	-.36	.99
Depression	.54	76	.592	.12	.13	.14	-.36	.64
Psychomotor	-.19	72	.853	-.04	.06	-.07	-.76	.63
3-month								
Anxiety	-.90	599	.371	-.07	.11	-.22	-.71	.26
Depression	-1.32	599	.189	-.11	.19	-.22	-.55	.11
Psychomotor	-1.74	599	.083	-.14	.29	-.39	-.83	.05
6-month								
Anxiety	-.67	598	.502	-.05	.08	-.16	-.63	.31
Depression	-1.90	598	.058	-.16	.37	-.32	-.65	.01
Psychomotor	-1.34	598	.181	-.11	.20	-.31	-.75	.14
12-month								
Anxiety	-1.17	513	.244	-.10	.16	-.30	-.81	.21
Depression	-1.33	513	.183	-.12	.21	-.25	-.62	.12
Psychomotor	-1.81	513	.070	-.16	.33	-.44	-.91	.04
24-month								
Anxiety	.27	480	.786	.03	.06	.07	-.44	.58
Depression	-.92	480	.358	-.08	.11	-.18	-.56	.20
Psychomotor	-.58	480	.564	-.05	.07	-.14	.63	.34

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Number of orthopaedic injuries (three groups). To provide a more detailed examination of the relationship between orthopaedic injury and the HADS post-TBI, participants were categorized according to three groups, based upon the number of orthopaedic injuries sustained (no injury; one injury; two or more injuries). Due to differing attendance rates post-injury, sample sizes varied for each analysis, ranging from 380 to 601 participants (see Figure 6.1). One-way between-subjects ANOVAs were conducted on the HADS data of the three groups at each follow-up assessment (Table 6.16). Mean HADS scores and standard deviations are shown in Table C4 (Appendix C). The mean scores for each HADS factor are plotted for the Anxiety factor (Figure C9 – Appendix C), Depression factor (Figure 6.6), and Psychomotor factor (Figure 6.7)

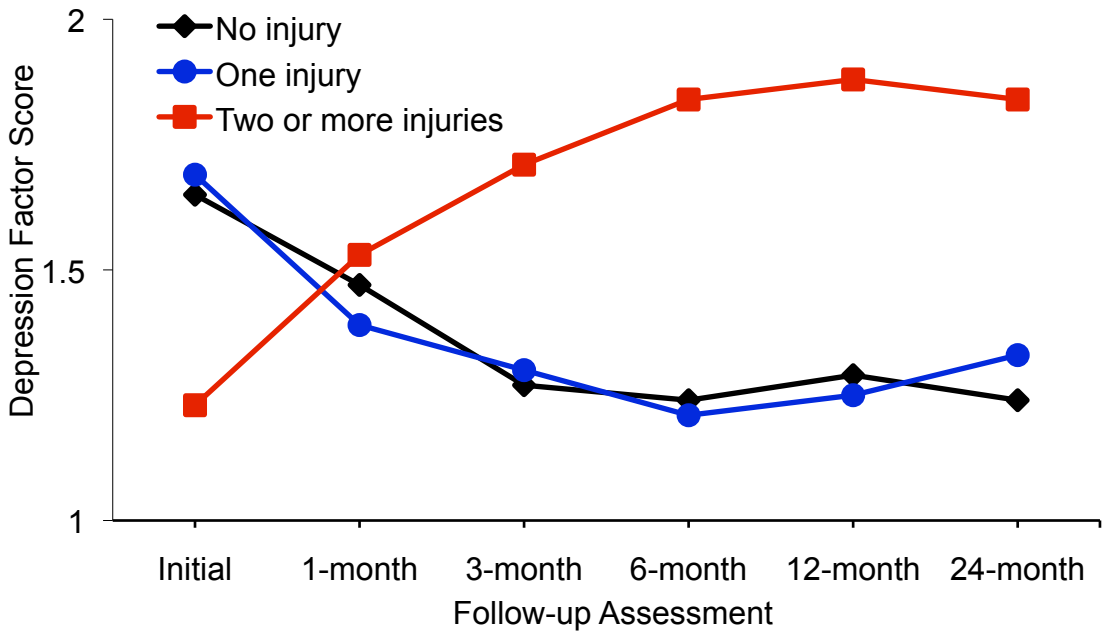

Figure 6.6. Mean depression factor scores over time for no. of orthopaedic injuries (three groups).

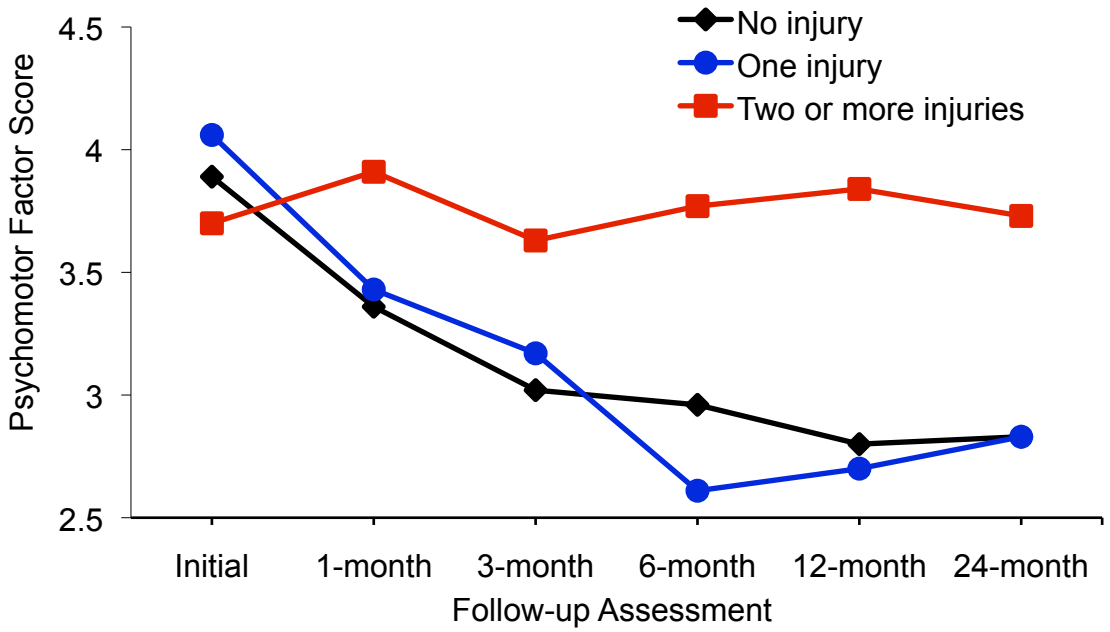

Figure 6.7. Mean psychomotor factor scores over time for no. of orthopaedic injuries (three groups).

On the Anxiety factor (Figure C9; Table 6.16), there was a trend for differences in mean scores between the groups at the initial (p = .084), 6-month (p = .061), and 12-month (p = .070) follow-ups. Significant differences in mean depression scores (Figure 6.6; Table 6.16) were found between the groups at the 6-month, 12-month, and 24-month follow-ups (p < .05). On the Psychomotor factor (Figure 6.7; Table 6.16), significant differences in mean scores were found between the groups at the 6-month, 12-month, and 24-month follow-ups (p < .01). There was a trend for a difference in mean psychomotor scores between the groups at the 3-month follow-up (p = .070). η^2_{partial} indicated small effect sizes.

Table 6.17 displays Tukey post-hoc tests performed for the HADS factors that were significant or indicated a trend for differences between the groups (for the full table of post-hoc comparisons see 'Output – Study 2' in Appendix C on the CD). At 3 months, there was a trend for the two or more injuries group to show higher mean depression (p = .080) and psychomotor (p = .056) scores than the no injury group. At 6 months, the two or more injuries group showed significantly higher mean depression and psychomotor scores than the

no injury groups ($p < .01$), and there was a trend for the two or more injuries group to report higher mean anxiety scores than the no injury group ($p = .092$). At 6 months, the two or more injuries group showed significantly higher mean depression ($p < .05$) and psychomotor ($p < .01$) scores than the one injury group, and there was a trend for the two or more injuries group to show a higher mean anxiety score than the one injury group ($p = .057$).

At 12 months, the two or more injuries group showed significantly higher mean depression ($p < .05$) and psychomotor ($p < .001$) scores than the no injury group, and a trend for a higher mean anxiety score than the no injury group ($p = .072$). At 12 months, the two or more injuries group showed a significantly higher mean psychomotor score than the one injury group ($p < .01$), and there was a trend for the two or more injuries group to report a higher mean depression score than the one injury group ($p = .086$). At 24 months, the two or more injuries group showed significantly higher mean depression ($p < .05$) and psychomotor ($p < .001$) scores than the no injury group, and a significantly higher mean psychomotor score than the one injury group ($p < .05$).

Table 6.16

One-way ANOVA for No. of Orthopaedic Injuries (Three Groups) on the HADS Factors

HADS Factor/ Follow-up	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Initial (<15 days)	2	490	2.49	.084	.01	.50
1-month	2	377	.52	.597	.00	.40
3-month	2	598	.72	.489	.00	.59
6-month	2	198	2.84	.061	.01	.59
12-month	2	177	2.69	.070	.01	.52
24-month	2	479	2.08	.127	.01	.49
Depression						
Initial (<15 days)	2	490	.81	.445	.00	.50
1-month	2	377	.06	.940	.00	.40
3-month	2	188	2.24	.109	.01	.59
6-month	2	203	4.49*	.012	.02	.89
12-month	2	180	3.84*	.023	.01	.52
24-month	2	479	3.32*	.037	.01	.49
Psychomotor						
Initial (<15 days)	2	490	.25	.780	.00	.50
1-month	2	377	.06	.940	.00	.40
3-month	2	598	2.67	.070	.01	.59
6-month	2	597	5.87	.003	.02	.89
12-month	2	187	7.20***	.001	.03	.95
24-month	2	479	4.66**	.010	.02	.81

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6.17

Significant/Trend Tukey Post-Hoc Tests for No. of Orthopaedic Injuries (Three Groups) on the HADS Factors

HADS Factor/ Follow-up	Comparison	*SE*	*p*
Anxiety			
6-month	No injury & Two or more injuries	.29	.092
6-month	One injury & Two or more injuries	.38	.057
12-month	No Injury & Two or more injuries	.31	.072
Depression			
3-month	No Injury & Two or more injuries	.20	.080
6-month	No Injury & Two or more injuries	.20	.009
6-month	One injury & Two or more injuries	.27	.050
12-month	No Injury & Two or more injuries	.22	.023
12-month	One injury & Two or more injuries	.30	.086
24-month	No Injury & Two or more injuries	.23	.028
Psychomotor			
3-month	No Injury & Two or more injuries	.27	.056
6-month	No Injury & Two or more injuries	.27	.009
6-month	One injury & Two or more injuries	.36	.004
12-month	No Injury & Two or more injuries	.29	.001
12-month	One injury & Two or more injuries	.38	.008
24-month	No Injury & Two or more injuries	.30	.008
24-month	One injury & Two or more injuries	.39	.050

Number of orthopaedic injuries (four groups). A frequency analysis indicated cell sizes were large enough to analyse if the two or more injuries group was split into a *two injuries* group and a *three or more injuries* group (see 'Output – Study 2' in Appendix C on the CD). Therefore, a further series of ANOVAs were performed to examine differences in participants' HADS scores based upon the number of orthopaedic injuries sustained, with

four groups (no injury; one injury; two injuries; three or more injuries). One-way between-subjects ANOVAs were conducted on the HADS data of the four groups at each follow-up assessment (Table 6.18). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 380 to 601 participants (see Figure 6.1). Mean HADS scores and standard deviations are shown in Table C5 (Appendix C). The mean scores for each HADS factor are plotted in Figures 6.8, 6.9, and 6.10.

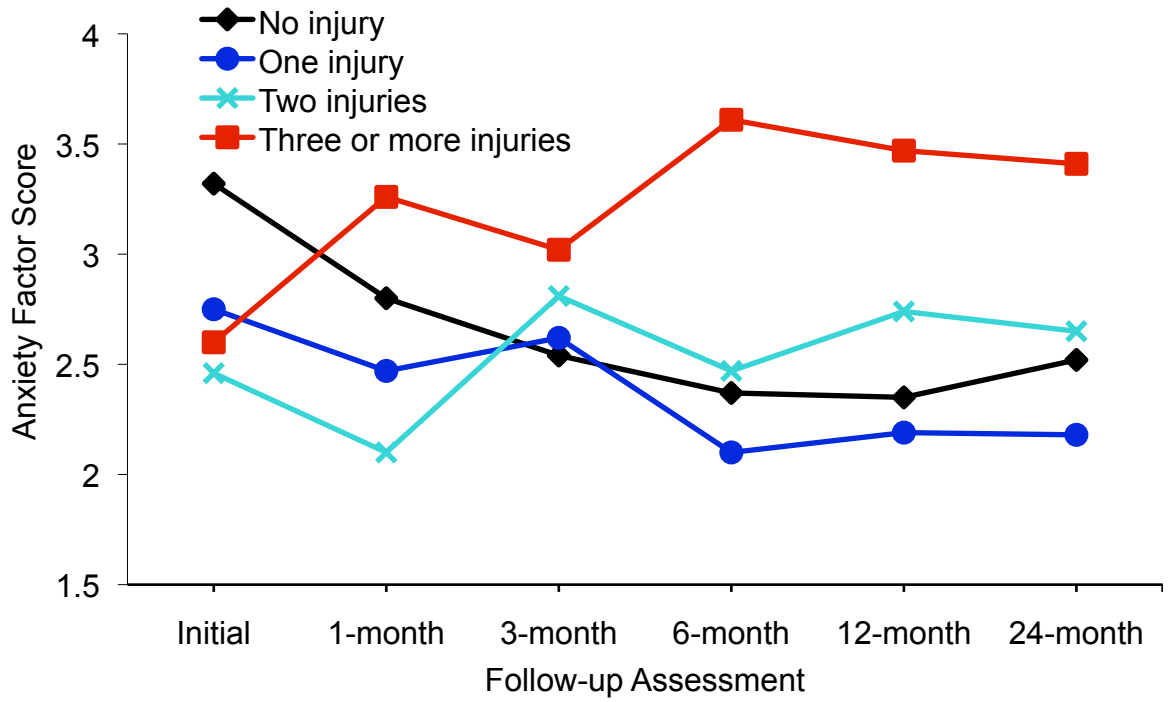

Figure 6.8. Mean anxiety factor scores over time for no. of orthopaedic injuries (four groups).

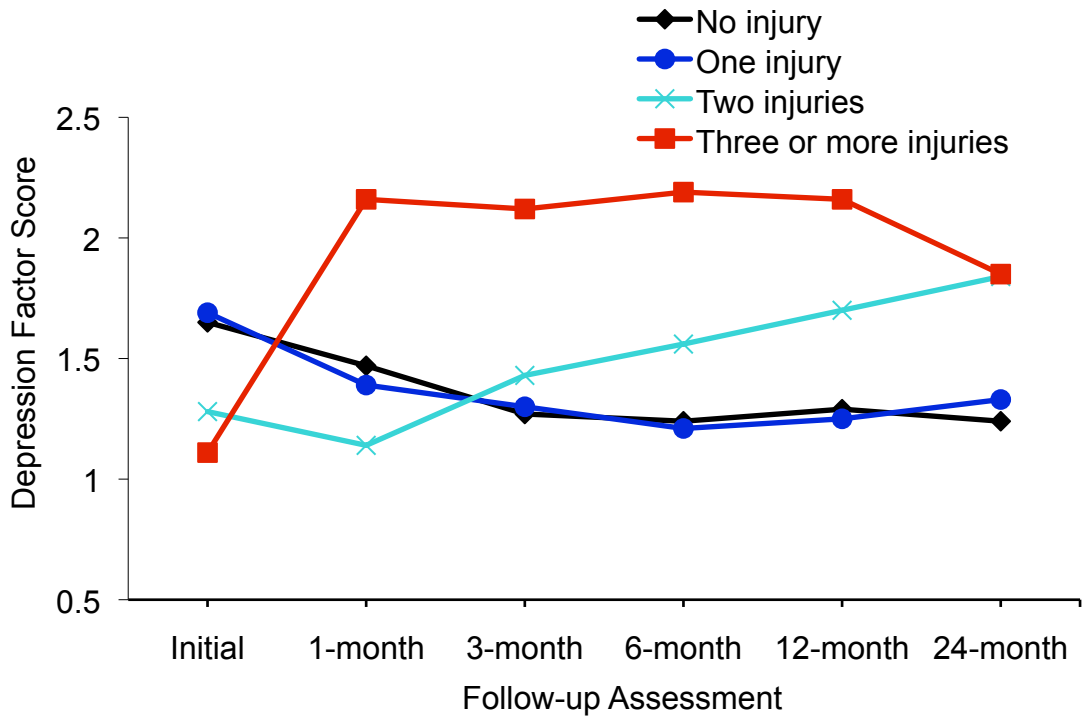

Figure 6.9. Mean depression factor scores over time for no. of orthopaedic injuries (four groups).

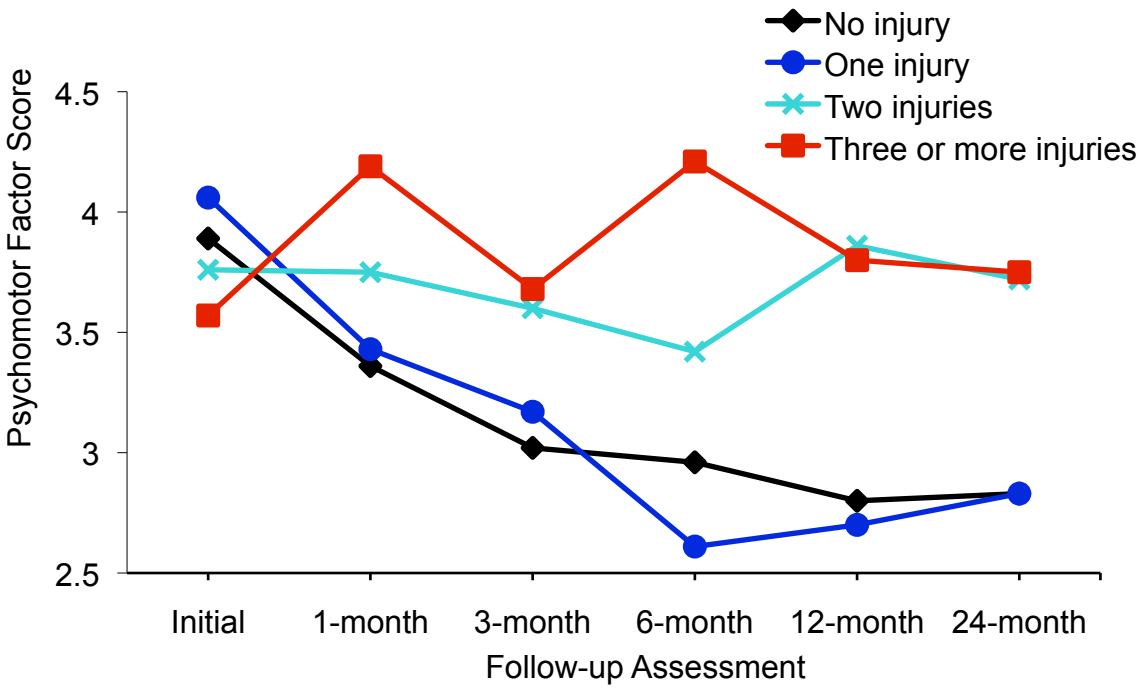

Figure 6.10. Mean psychomotor factor scores over time for no. of orthopaedic injuries (four groups).

Anxiety factor. On the Anxiety factor (Figure 6.8; Table 6.18), a significant difference in mean scores was found between the groups at the 6-month follow-up ($p < .05$), with $\eta^2_{partial}$ indicating a small effect size. Table 6.19 displays Tukey post-hoc tests for the Anxiety factor that were significant or indicated a trend for differences between groups (for the full table of post-hoc tests for each of the HADS factors see 'Output – Study 2' in Appendix C on the CD). At the 6-month follow-up, the three or more injuries group showed significantly higher mean anxiety scores than the no injury group ($p < .05$) and the one injury group ($p < .05$). The three or more injuries group displayed significantly higher mean anxiety scores than the no injury group at the 12-month follow-up ($p < .01$). There was a trend for the three or more injuries group to show higher mean anxiety scores than the one injury group at the 12-month ($p = .082$) and 24-month ($p = .076$) follow-up.

Depression factor. On the Depression factor (Figure 6.9; Table 6.18), a significant difference in mean scores was found between the groups at the 6-month follow-up ($p < .01$). There was a trend for significant differences in mean scores between the groups at the 3-month ($p = .093$), 12-month ($p = .052$), and 24-month ($p = .086$) follow-ups. $\eta^2_{partial}$ indicated small effect sizes.

Tukey post-hoc tests (Table 6.19) showed at the 3-month follow-up, the three or more injuries group reported significantly higher mean depression scores than the no injury group ($p < .05$) and a trend for higher mean depression scores than the one injury group ($p = .085$). At the 6-month follow-up, the three or more injuries group displayed significantly higher mean depression scores than the no injury group ($p < .01$) and the one injury group ($p = .021$). At the 12-month follow-up, the three or more injuries group showed significantly higher mean depression scores than the no injury group ($p < .05$), and there was a trend for the three or more injuries group to display higher mean depression scores than the one injury group ($p = .092$).

Psychomotor factor. On the Psychomotor factor (Figure 6.10; Table 6.18), a significant difference in mean scores was found between the groups at the 6-month ($p < .01$), 12-month ($p < .01$), and 24-month ($p < .05$) follow-ups. $\eta^2_{partial}$ indicated small effect sizes. Tukey post-hoc tests (Table 6.19) showed at the 6-month follow-up, the three or more injuries group reported significantly higher ($p < .01$) mean psychomotor scores than the no injury group and the one injury group. At the 12-month follow-up, the two injuries group displayed significantly higher ($p < .05$) mean psychomotor scores than the no injury group and the one injury group.

Table 6.18

One-way ANOVA for No. of Orthopaedic Injuries (Four Groups) on the HADS Factors

HADS Factor/Follow-up	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Initial (<15 days)	3	489	1.66	.174	.01	.44
1-month	3	30	.72	.547	.01	.34
3-month	3	597	.53	.665	.00	.52
6-month	3	596	3.49*	.015	.02	.85
12-month	3	120	2.09	.106	.01	.45
24-month	3	478	1.98	.116	.01	.91
Depression						
Initial (<15 days)	3	489	.60	.642	.00	.44
1-month	3	376	.88	.451	.01	.34
3-month	3	102	2.20	.093	.01	.52
6-month	3	126	3.58*	.016	.02	.85
12-month	3	116	2.66	.052	.02	.78
24-month	3	478	2.21	.086	.01	.91
Psychomotor						
Initial (<15 days)	3	489	.18	.910	.00	.44
1-month	3	376	.58	.628	.00	.34
3-month	3	597	1.79	.148	.01	.52
6-month	3	139	4.25**	.007	.02	.85
12-month	3	511	4.61**	.003	.03	.93
24-month	3	478	3.10*	.026	.02	.75

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6.19

Significant/Trend Tukey Post-Hoc Tests for No. of Orthopaedic Injuries (Four Groups) on the HADS Factors

HADS Factor/ Follow-up	Comparison	*SE*	*p*
Anxiety			
6-month	No injury & Three or more injuries	.41	.016
6-month	One injury & Three or more injuries	.48	.010
12-month	No injury & Three or more injuries	.47	.007
12-month	One injury & Three or more injuries	.54	.082
24-month	One injury & Three or more injuries	.51	.076
Depression			
3-month	No injury & Three or more injuries	.30	.026
3-month	One injury & Three or more injuries	.35	.085
6-month	No injury & Three or more injuries	.29	.006
6-month	One injury & Three or more injuries	.34	.021
12-month	No injury & Three or more injuries	.34	.050
12-month	One injury & Three or more injuries	.39	.092
Psychomotor			
6-month	No injury & Three or more injuries	.39	.009
6-month	One injury & Three or more injuries	.46	.003
12-month	No injury & Two injuries	.36	.017
12-month	One injury & Two injuries	.44	.040

Severity of orthopaedic injury (three groups). Additional cross-sectional analyses were conducted to explore the impact of severity of orthopaedic damage on participants' HADS scores. Participants were categorized according to three severity of orthopaedic injury groups (no/mild injury; one severe injury; two or more severe injuries). One-way between-subjects ANOVAs were conducted on the HADS data of the three groups at each follow-up assessment (Table 6.20). Mean HADS scores and standard deviations are shown in Table C6 (Appendix C). The mean scores for each HADS factor are plotted for the Anxiety factor (Figure C10 – Appendix C), Depression factor (Figure 6.11), and Psychomotor factor (Figure C11 – Appendix C).

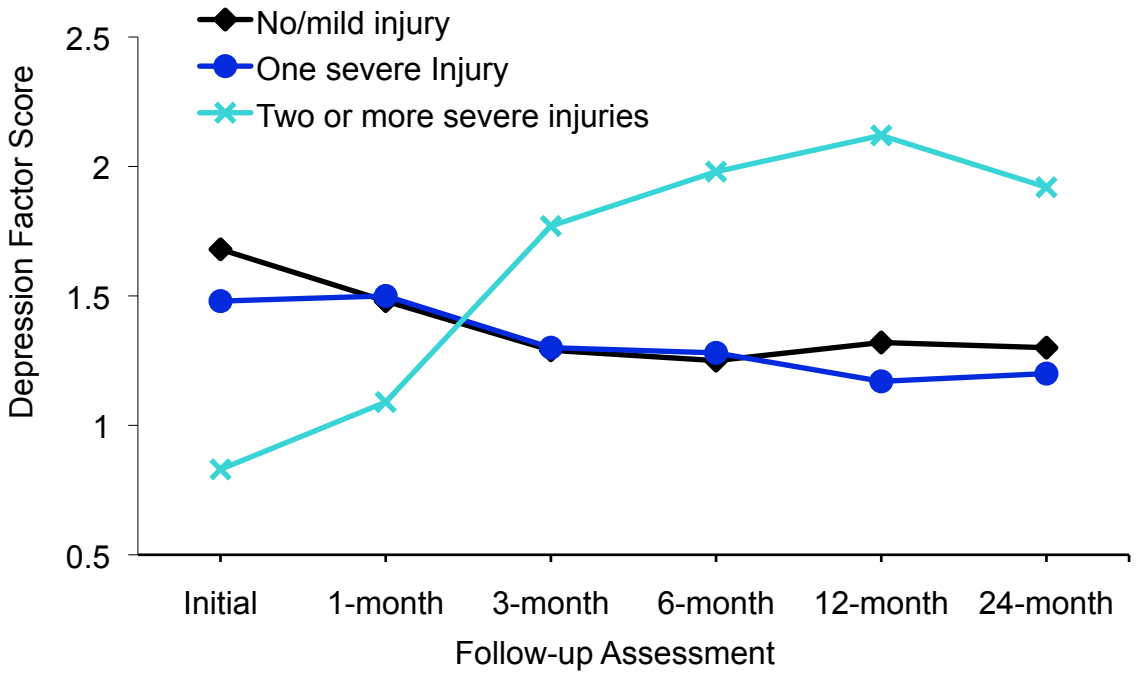

Figure 6.11. Mean depression factor scores over time for severity of orthopaedic injury (three groups).

On the Anxiety factor (Figure C10 – Appendix C; Table 6.20), significant differences in mean scores were found between the groups at the initial, 6-month, and 12-month follow-ups ($p < .05$). Significant differences in mean depression scores (Figure 6.11; Table 6.20) were found between the groups at the 6- and 12-month follow-ups ($p < .05$), with a trend for

a difference in mean depression scores between the groups at the 24-month follow-up (p = .079). On the Psychomotor factor, significant differences in mean scores were found between the groups at the 6-month and 12-month follow-ups ($p < .05$; Figure C11 – Appendix C; Table 6.20). $\eta^2_{partial}$ indicated small effect sizes for each of the HADS factors.

Table 6.21 displays Tukey post-hoc tests performed for the HADS factors that were significant or indicated a trend for differences between groups (for the full table of post-hoc comparisons see 'Output – Study 2' in Appendix C on the CD). At the initial follow-up, the no/mild injury group showed significantly higher mean anxiety scores than the one severe injury group ($p < .05$). At the 6-month follow-up, the two or more severe injuries group displayed significantly higher mean anxiety ($p < .05$), depression ($p < .01$), and psychomotor scores ($p < .05$), than the no/mild injury group. At the 6-month follow-up, the two or more severe injuries group also displayed a significantly higher mean anxiety score than the one severe injury group ($p < .05$), a strong trend for a higher mean depression score than the one severe injury group (p = .051), and a significantly higher mean psychomotor score than the one severe injury group ($p < .05$).

At 12 months, the two or more severe injuries group showed significantly higher mean anxiety, depression, and psychomotor scores ($p < .01$), than the no/mild injury group, and significantly higher mean anxiety ($p < .01$), depression ($p < .05$), and psychomotor ($p < .05$) scores than the one severe injury group. At 24 months, there were trends for the two or more severe injury group to display higher mean depression scores than the no/mild injury (p = .081) and the one severe injury (p = .098) groups.

Table 6.20

One-way ANOVA for Severity of Orthopaedic Injury (Three Groups) on the HADS Factors

HADS Factor/ Follow-up	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
Anxiety						
Initial (<15 days)	2	490	3.72*	.01	.025	.50
1-month	2	377	.57	.00	.566	.40
3-month	2	134	2.27	.01	.107	.59
6-month	2	597	3.83*	.01	.022	.59
12-month	2	106	4.58*	.02	.012	.83
24-month	2	479	1.76	.01	.171	.81
Depression						
Initial (<15 days)	2	490	2.23	.01	.108	.50
1-month	2	377	.51	.00	.601	.40
3-month	2	115	1.76	.01	.176	.59
6-month	2	101	3.20*	.02	.045	.89
12-month	2	107	4.56*	.02	.013	.83
24-month	2	479	2.56	.01	.079	.81
Psychomotor						
Initial (<15 days)	2	490	1.27	.01	.283	.50
1-month	2	377	.15	.00	.857	.40
3-month	2	598	2.12	.01	.121	.59
6-month	2	135	3.88*	.01	.023	.59
12-month	2	114	4.25*	.02	.017	.83
24-month	2	479	1.62	.01	.198	.81

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6.21

Significant/Trend Tukey Post-Hoc Tests for Severity of Orthopaedic Injury (Three Groups) on the HADS Factors

HADS Factor/ Follow-up	Comparison	*SE*	*p*
Anxiety			
Initial	No/mild injury & One severe injury	.39	.050
6-month	No/mild injury & Two or more severe injuries	.35	.043
6-month	One severe injury & Two or more severe injuries	.43	.020
12-month	No/mild injury & Two or more severe injuries	.37	.007
12-month	One severe injury & Two or more severe injuries	.46	.007
Depression			
6-month	No/mild injury & Two or more severe injuries	.24	.008
6-month	One severe injury & Two or more severe injuries	.30	.051
12-month	No/mild injury & Two or more severe injuries	.27	.009
12-month	One severe injury & Two or more severe injuries	.33	.013
24-month	No/mild injury & Two or more severe injuries	.29	.081
24-month	One severe injury & Two or more severe injuries	.35	.098
Psychomotor			
6-month	No/mild injury & Two or more severe injuries	.33	.014
6-month	One severe injury & Two or more severe injuries	.41	.026
12-month	No/mild injury & Two or more severe injuries	.35	.007
12-month	One severe injury & Two or more severe injuries	.43	.036

Severity of orthopaedic injury (four groups). A frequency analysis showed the majority of participants in the no/mild injury group did not sustain an orthopaedic injury (see 'Output – Study 2' in Appendix C on the CD). Therefore, a further series of one-way between-subjects ANOVAs were performed to examine differences in HADS scores between four groups (no orthopaedic injury; mild orthopaedic injury; one severe orthopaedic injury; two or more severe orthopaedic injuries; Table 6.22). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 380 to 601 participants (see Figure 6.1). Mean HADS scores and standard deviations are shown in Table C7 (Appendix C). The mean scores for each HADS factor are plotted in Figures 6.12, 6.13, and 6.14.

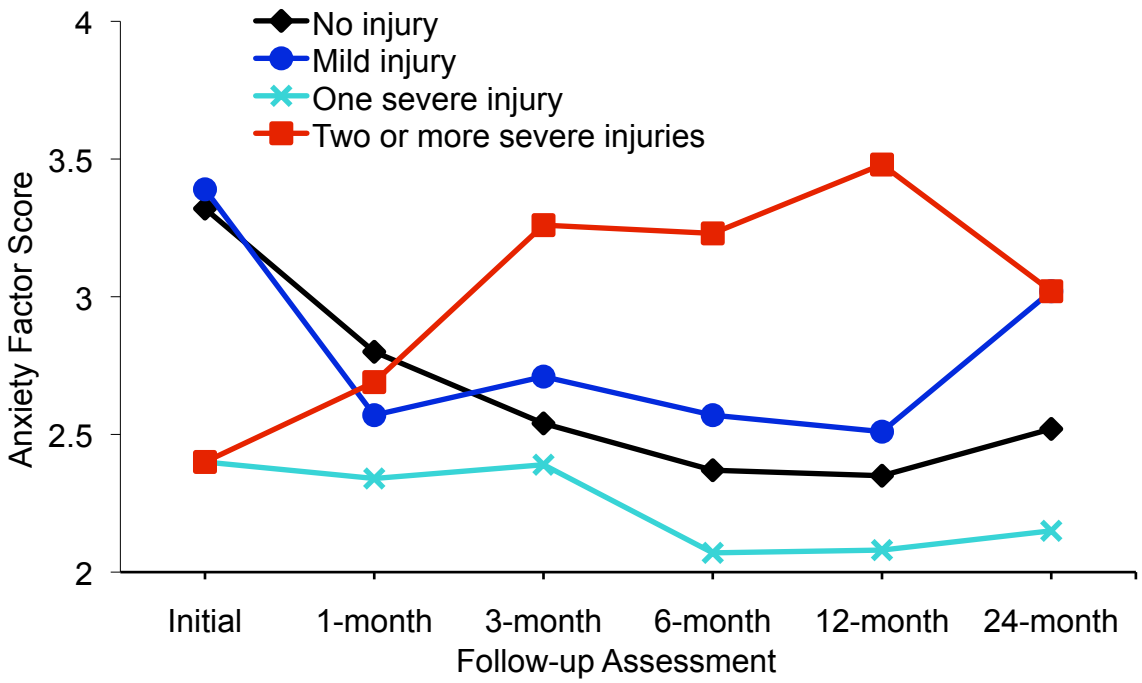

Figure 6.12. Mean anxiety factor scores over time for severity of orthopaedic injury (four groups).

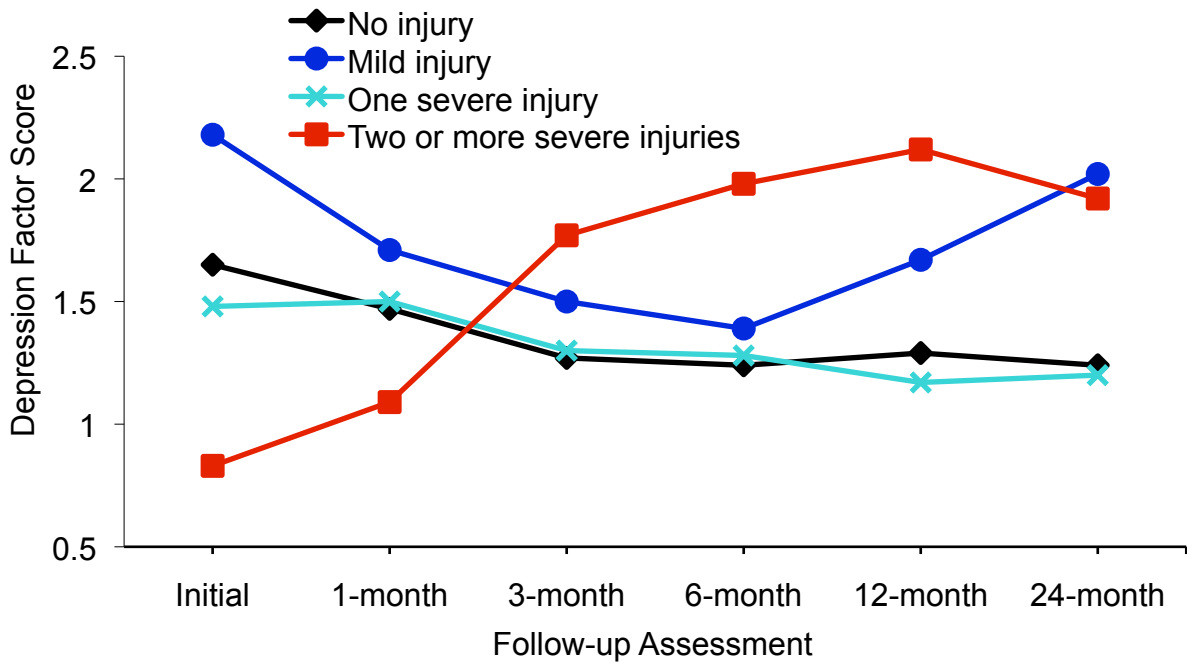

Figure 6.13. Mean depression factor scores over time for severity of orthopaedic injury (four groups).

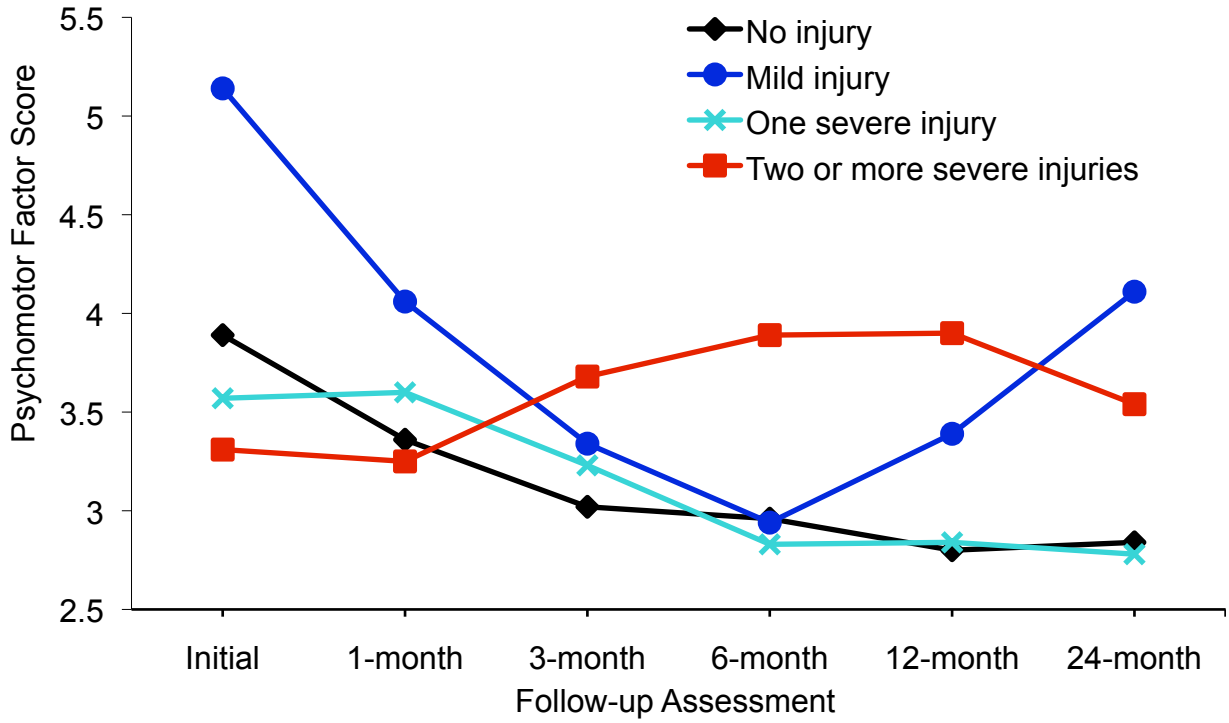

Figure 6.14. Mean psychomotor factor scores over time for severity of orthopaedic injury (four groups).

Anxiety factor. On the Anxiety factor (Figure 6.12; Table 6.22), a significant difference in mean scores was found between the groups at the 6- and 12-month follow-ups ($p < .05$). There was a trend for a difference in mean anxiety score at the initial follow-up ($p = .060$). $\eta^2_{partial}$ indicated small effect sizes.

Table 6.23 displays Tukey post-hoc tests that were significant or indicated a trend for differences between groups on the Anxiety factor (for the full table of post-hoc comparisons see 'Output – Study 2' in Appendix C on the CD). At the initial follow-up, there was a trend for the no injury group to display higher mean anxiety scores than the two or more severe injuries group ($p = .091$). At the 6-month follow-up, the two or more severe injuries group showed a significantly higher mean anxiety score than the one severe injury group ($p < .05$), and there was a trend for the two or more severe injuries group to show a higher mean anxiety score than the no injury group ($p = .071$). At the 12-month follow-up, the two or more severe injuries displayed a significantly higher mean anxiety score than the no injury group and the one severe injury group ($p < .05$).

Depression factor. On the Depression factor (Figure 6.13; Table 6.22), a significant difference in mean scores was found between the groups at the 6-month, 12-month, and 24-month follow-ups ($p < .05$). A trend was found for a significant difference in mean depression scores between the groups at the initial follow-up ($p = .089$). $\eta^2_{partial}$ indicated small effect sizes.

Tukey post-hoc tests (Table 6.23) showed there was a trend at the initial follow-up for the mild injury group to report a higher mean depression score than the two or more severe injuries group ($p = .064$). At the 6-month follow-up, the two or more severe injuries group showed a significantly higher mean depression score than the no injury group ($p < .05$), and a trend for a higher mean depression score than the one severe injury group ($p = .090$). At the 12-month follow-up, the two or more severe injuries group showed a significantly higher

mean depression score than the no injury and one severe injury groups ($p < .05$). At 24 months, there was a trend for the two or more severe injuries group to show a higher mean depression score than the no injury group ($p = .087$).

Psychomotor factor. On the Psychomotor factor (Figure 6.14; Table 6.22), significant differences in mean scores were found between the groups at the initial ($p < .05$), 6-month ($p < .05$), 12-month ($p < .05$), and 24-month ($p < .01$) follow-ups, with η^2_{partial} indicating small effect sizes. Tukey post-hoc tests (Table 6.23) showed at the initial follow-up, the mild injury group reported a significantly higher mean psychomotor score than the one severe injury group, the no injury group and the two or more severe injuries group ($p < .05$). At the 6-month follow-up, the two or more severe injuries group displayed a significantly higher mean psychomotor score than the no injury and one severe injury groups ($p < .05$). At the 12-month follow-up, the two or more severe injuries group displayed a significantly higher mean psychomotor score than the no injury group ($p < .01$) and a strong trend for a higher mean psychomotor score than the one severe injury group ($p = .064$). At the 24-month follow-up, the mild injury group displayed a significantly higher man psychomotor score than the no injury and one severe injury groups ($p < .05$).

Table 6.22

One-way ANOVA for Severity of Orthopaedic Injury (Four Groups) on the HADS Factors

HADS Factor/Follow-up	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
Anxiety						
Initial (<15 days)	3	489	2.48	.01	.060	.44
1-month	3	376	.44	.00	.724	.34
3-month	3	159	1.55	.01	.203	.52
6-month	3	596	2.62*	.01	.050	.52
12-month	3	134	3.49*	.02	.018	.78
24-month	3	478	1.56	.01	.198	.43
Depression						
Initial (<15 days)	3	489	2.19	.01	.089	.44
1-month	3	376	.46	.00	.710	.34
3-month	3	152	1.44	.01	.233	.52
6-month	3	163	3.11*	.02	.028	.85
12-month	3	135	3.85*	.02	.011	.78
24-month	3	478	3.39*	.02	.018	.75
Psychomotor						
Initial (<15 days)	3	489	3.10*	.02	.026	.76
1-month	3	376	.65	.01	.586	.34
3-month	3	597	1.64	.01	.179	.52
6-month	3	596	2.85*	.01	.037	.52
12-month	3	106	3.52*	.02	.018	.78
24-month	3	478	3.79*	.02	.010	.75

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6.23

Significant/Trend Tukey Post-Hoc Tests for Severity of Orthopaedic Injury (Four Groups) on the HADS Factors

Follow-up	Comparison	Anxiety		Depression		Psychomotor	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial (<15 days)	No injury & Mild injury	–	–	–	–	.48	.048
Initial (<15 days)	No injury & Two or more severe injuries	.40	.091	–	–	–	–
Initial (<15 days)	Mild injury & One severe injury	–	–	–	–	.57	.032
Initial (<15 days)	Mild injury & Two or more severe injuries	–	–	.55	.064	.71	.050
6-month	No injury & Two or more severe injuries	.35	.071	.24	.013	.33	.027
6-month	One severe injury & Two or more severe injuries	.43	.038	.30	.090	.41	.047
12-month	No injury & Two or more severe injuries	.37	.013	.27	.012	.35	.009
12-month	One severe injury & Two or more severe injuries	.46	.013	.33	.023	.43	.064
24-month	No injury & Two or more severe injuries	–	–	.29	.087	–	–
24-month	No injury & Mild injury	–	–	–	–	.45	.024
24-month	Mild injury & One severe injury	–	–	–	–	.51	.048

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

Longitudinal sample. Mixed between & within subjects repeated measures ANOVAs were conducted to assess the impact of participants' orthopaedic injury on HADS scores across six time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 101 participants who came to every follow-up assessment and completed the HADS. Two groups were included in the analyses based upon the presence of orthopaedic injury, the no orthopaedic injury group (n = 78) and the orthopaedic injury group (n = 23). Mean HADS scores and standard deviations are shown in Table 6.24.

Table 6.24

Descriptive Statistics for Orthopaedic Injury on the HADS Factors – Longitudinal Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
No orthopaedic injury	2.60	2.29	2.05	1.93	1.91	2.13
	(2.26)	(2.11)	(2.05)	(2.05)	(2.15)	(1.98)
Orthopaedic injury	1.73	1.35	1.70	1.15	1.39	1.63
	(1.66)	(1.72)	(1.75)	(1.48)	(1.49)	(1.73)
Depression						
No orthopaedic injury	1.65	1.24	1.04	.94	.89	.91
	(1.88)	(1.62)	(1.48)	(1.35)	(1.39)	(1.54)
Orthopaedic injury	1.40	1.27	1.01	1.00	1.10	1.13
	(1.69)	(1.47)	(1.22)	(1.41)	(1.44)	(1.77)
Psychomotor						
No orthopaedic injury	3.47	2.94	2.68	2.62	2.43	2.43
	(2.24)	(2.37)	(2.05)	(1.88)	(2.25)	(1.99)
Orthopaedic injury	3.42	3.15	2.70	1.84	2.31	2.33
	(1.54)	(2.68)	(2.37)	(1.84)	(1.80)	(2.18)

Note. Mean values are displayed with standard deviations presented in parentheses.

Table 6.25 shows the tests of within-subjects effects for orthopaedic injury on the HADS factors. There was a main effect for time on the Anxiety factor, $F(4, 387) = 2.56$, $p = .039$, $\eta^2_{partial} = .03$; and the Psychomotor factor, $F(4, 431) = 9.12$, $p < .001$, $\eta^2_{partial} = .08$. When a more stringent alpha level was adopted ($p < .01$), there was a trend for a significant main effect for time on the Depression factor, $F(4, 358) = 2.93$, $p = .025$, $\eta^2_{partial} = .03$. Small effect sizes were found for the main effect of time on the Anxiety and Depression factors, and a medium effect size for the Psychomotor factor. These results indicate TBI participants showed a significant reduction over time in their anxiety and depression scores and a trend for a reduction in psychomotor scores.

Bonferroni post-hoc comparisons for time, for each of the HADS factors are displayed in 'Output – Study 2' (Appendix C on the CD). Table C8 (Appendix C) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. Significant differences in mean psychomotor scores were found between the initial and 3-month follow-up ($p = .044$), the initial and 6-month follow-up ($p < .001$), the initial and 12-month follow-up ($p = .001$), and the initial and 24-month follow-up ($p = .002$). Significant differences in mean psychomotor scores were also found between the 1-month and 6-month follow-up ($p = .001$), and the 1-month and 12-month follow-up ($p = .012$). There was a weak trend for a difference in mean psychomotor scores between the 1-month and 24-month follow-up ($p = .091$).

Tests of between-subjects effects for orthopaedic injury on the HADS factors are displayed in Table 6.25. The main effect comparing the two orthopaedic injury groups was not significant for the Anxiety factor, $F(1, 99) = 2.62$, $p = .109$, $\eta^2_{partial} = .03$; Depression factor, $F(1, 99) = .02$, $p = .891$, $\eta^2_{partial} = .00$; and the Psychomotor factor, $F(1, 99) = .11$, $p = .744$, $\eta^2_{partial} = .00$. This indicates there were no significant differences between the mean HADS scores of the groups. The Time x Orthopaedic Injury interaction was non-significant

for the Anxiety factor, $F(4, 387) = .76$, $p = .550$, $\eta^2_{partial} = .01$; the Depression factor, $F(4, 358) = .45$, $p = .757$, $\eta^2_{partial} = .00$; and the Psychomotor factor, $F(4, 431) = 1.18$, $p = .318$, $\eta^2_{partial} = .01$.

Table 6.25

Tests of Within-Subjects & Between-Subjects Effects for Orthopaedic Injury on the HADS Factors

HADS Factor/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	387	2.56*	.039	.03	.72
Orthopaedic injury	1	99	2.62	.109	.03	.36
Time x Ortho[a]	4	387	.76	.550	.01	.24
Depression						
Time since TBI[a]	4	358	2.93*	.025	.03	.75
Orthopaedic injury	1	99	.02	.891	.00	.05
Time x Ortho[a]	4	358	.45	.757	.00	.15
Psychomotor						
Time since TBI[a]	4	431	9.12***	< .001	.08	1.00
Orthopaedic injury	1	99	.11	.744	.00	.06
Time x Ortho[a]	4	431	1.18	.318	.01	.39

Note. [a]Greenhouse Geisser results are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

6.3.5 Cause of TBI

Cross-sectional sample. One-way between-subjects ANOVAs were conducted at each follow-up to compare participants' HADS scores based on their cause of injury (Table 6.27). Four groups were included in the analyses: transport, assault, fall, and sport. Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 449 to 568 participants (see Figure 6.1). Table 6.26 displays the mean HADS scores and standard deviations from these analyses. The mean scores were plotted over time

for the Anxiety factor (Figure 6.15), Depression factor (Figure C12 – Appendix C), and Psychomotor factor (Figure C13 – Appendix C).

Table 6.26

Descriptive Statistics for Cause of Injury on the HADS Factors – Cross-Sectional Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Transport	3.17	2.63	2.72	2.52	2.67	2.79
	(2.59)	(2.33)	(2.53)	(2.52)	(2.51)	(2.40)
Fall	2.76	2.45	2.37	2.26	1.95	1.97
	(2.52)	(2.22)	(2.41)	(2.41)	(2.28)	(2.21)
Assault	3.89	3.34	3.09	2.92	2.86	3.14
	(2.61)	(2.55)	(2.58)	(2.54)	(2.64)	(2.69)
Sport	2.54	2.25	1.55	1.68	1.68	1.94
	(1.92)	(2.23)	(1.64)	(1.74)	(2.08)	(2.09)
Depression						
Transport	1.70	1.62	1.58	1.50	1.66	1.59
	(1.80)	(1.92)	(1.83)	(1.83)	(1.96)	(1.83)
Fall	1.50	1.33	1.23	1.34	1.23	1.03
	(1.67)	(1.67)	(1.56)	(1.55)	(1.61)	(1.47)
Assault	1.94	1.70	1.39	1.35	1.39	1.57
	(1.86)	(1.74)	(1.80)	(1.84)	(1.82)	(2.14)
Sport	1.00	.72	.52	.49	.50	.54
	(1.52)	(1.24)	(.84)	(1.01)	(.91)	(1.08)
Psychomotor						
Transport	4.07	3.36	3.31	3.24	3.19	3.33
	(2.44)	(2.41)	(2.35)	(2.56)	(2.40)	(2.31)
Fall	3.64	3.31	2.91	2.93	2.65	2.51
	(2.18)	(2.36)	(2.10)	(2.02)	(2.01)	(2.09)
Assault	4.24	3.80	3.37	3.27	3.01	3.22
	(2.33)	(2.60)	(2.26)	(2.27)	(2.52)	(2.68)
Sport	3.01	2.58	2.01	1.81	2.09	2.26
	(1.86)	(2.09)	(1.73)	(1.59)	(1.74)	(1.83)

Note. Mean values are displayed with standard deviations presented in parentheses.

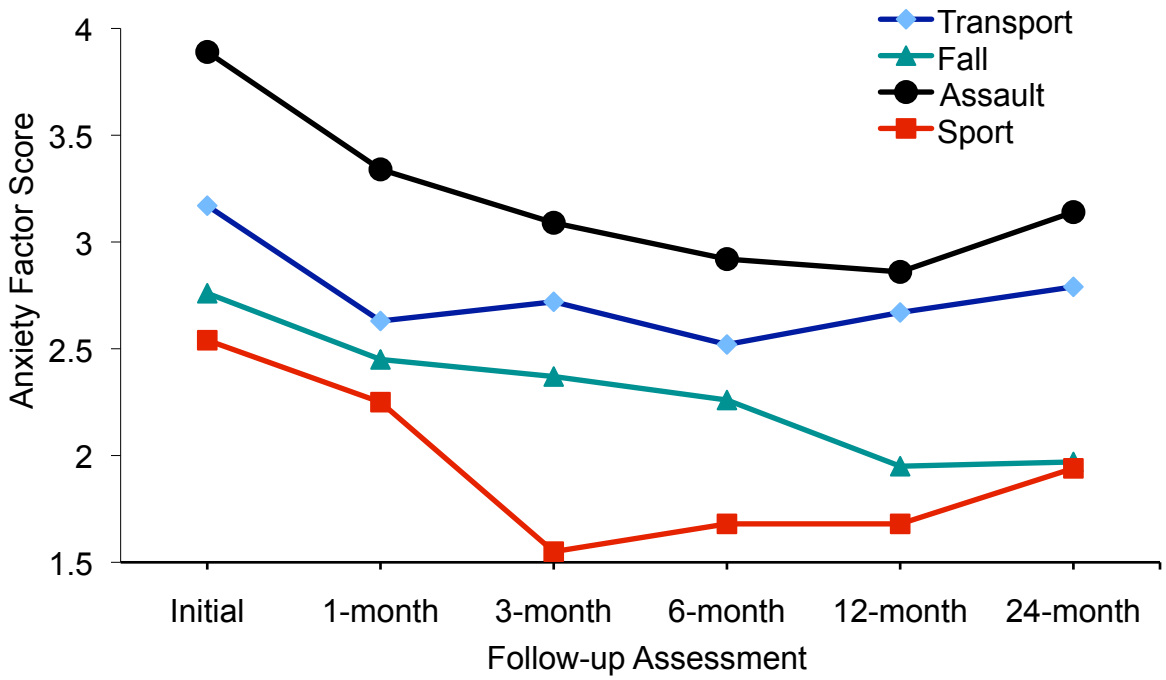

Figure 6.15. Mean anxiety factor scores over time for cause of injury (cross-sectional sample).

Anxiety factor. Significant differences in mean anxiety scores (Figure 6.15; Table 6.27) were found between the groups at each follow-up ($p < .001$ at the initial, 3-month, and 24-month follow-ups; $p < .01$ at the 6-month and 12-month follow-ups; $p < .05$ at the 1-month follow-up). $\eta^2_{partial}$ indicated small effect sizes.

Table 6.28 displays Tukey post-hoc tests that were significant or indicated a trend for differences between groups, for each of the HADS factors (for the full table of post-hoc comparisons see 'Output – Study 2' in Appendix C on the CD). The assault group showed significantly higher mean anxiety scores than the fall group at the initial ($p < .01$), 1-month ($p < .05$), 12-month ($p < .05$), and 24-month ($p < .01$) follow-ups, and a trend for a higher mean anxiety score than the fall group at 3-months ($p = .065$). The assault group showed significantly higher mean anxiety scores than the sport group at the initial ($p < .05$), 3-month ($p < .001$), 6-month ($p < .05$), 12-month ($p < .05$), and 24-month ($p < .05$) follow-ups, and a trend for a higher mean anxiety score than the Sport group at 1 month ($p = .087$). There was a

trend for the assault group to show a higher mean anxiety score than the transport group at the initial follow-up ($p = .054$).

The transport group displayed a significantly higher mean anxiety score than the sport group at 3 months ($p < .05$). The transport group showed a significantly higher mean anxiety score than the fall group at 24 months ($p < .05$), and there was a trend for the transport group to show a higher mean anxiety score than the fall group at 12 months ($p = .051$; see Figure 6.14).

Depression factor. On the Depression factor (Figure C12 – Appendix C; Table 6.27), significant differences in mean scores were found between the groups at each follow-up ($p < .05$ at the initial and 1-month follow-ups; $p < .001$ at the 3-month, 6-month, 12-month, and 24-month follow-ups). $\eta^2_{partial}$ indicated small effect sizes.

Tukey post-hoc tests (Table 6.28) showed the assault group reported significantly higher mean depression scores than the sport group at each follow-up ($p < .05$). The transport group displayed significantly higher mean depression scores than the sport group at 1 month ($p < .05$), 3 months ($p < .001$), 6 months ($p < .01$), 12 months ($p < .001$), and 24 months ($p < .01$). At 24 months, the transport group showed a significantly higher mean depression score than the fall group ($p < .05$). The fall group showed a significantly higher mean depression score than the sport group at 24 months ($p < .01$), and a trend for a higher mean depression score than the sport group at 3 months ($p = .071$; Figure C12).

Psychomotor factor. On the Psychomotor factor (Figure C13 – Appendix C; Table 6.27), significant differences in mean scores were found between the groups at the initial follow-up ($p < .05$), 3 months ($p < .001$), 6 months ($p < .001$), 12 months ($p < .05$), and 24 months ($p < .01$), and there was a trend for differences between the groups at 1 month ($p = .076$). $\eta^2_{partial}$ indicated small effect sizes.

Tukey post-hoc tests (Table 6.28) showed the assault group reported significantly higher mean psychomotor scores than the sport group at the initial ($p < .05$), 3-month ($p < .01$), and 6-month ($p < .001$) follow-ups, and a trend to report a higher mean psychomotor score than the sport group at 1 month ($p = .052$).

The transport group showed significantly higher mean psychomotor scores than the sport group at each follow-up ($p < .05$ at the initial, 12-month, and 24-month follow-ups; $p < .01$ at 1 month and 3 months; $p < .001$ at 6 months). The transport group displayed significantly higher mean psychomotor scores than the fall group at 24 months ($p < .05$). The fall group showed a significantly higher mean psychomotor score than the sport group at 6 months ($p < .05$), and there was a trend for the fall group to display a higher mean psychomotor score than the sport group at 3 months ($p = .087$; Figure C13).

Table 6.27

ANOVA for Cause of Injury on the HADS Factors – Cross-Sectional Sample

Follow-up/ HADS factor	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
Initial (<15 days)						
Anxiety	3	459	5.57***	.04	.001	.97
Depression	3	459	3.35*	.02	.019	.73
Psychomotor	3	459	3.73*	.02	.011	.73
1-month						
Anxiety	3	353	3.29*	.03	.021	.94
Depression	3	329	3.76*	.03	.011	.94
Psychomotor	3	353	2.32	.02	.076	.80
3-month						
Anxiety	3	473	5.93***	.03	.001	.95
Depression	3	515	6.60***	.03	< .001	.95
Psychomotor	3	428	5.92***	.03	.001	.95
6-month						
Anxiety	3	462	4.04*	.02	.007	.82
Depression	3	496	5.42**	.02	.001	.82
Psychomotor	3	480	6.74***	.03	< .001	.95
12-month						
Anxiety	3	328	4.86**	.03	.003	.91
Depression	3	426	6.70***	.03	< .001	.91
Psychomotor	3	355	3.74*	.02	.011	.75
24-month						
Anxiety	3	289	6.00***	.04	.001	.96
Depression	3	319	6.37***	.04	< .001	.96
Psychomotor	3	305	5.02**	.03	.002	.89

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6.28

Significant/Trend Tukey Post-hoc Tests for Cause of Injury on the HADS Factors – Cross-Sectional Sample

Follow-up	Comparison	Anxiety		Depression		Psychomotor	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial	TRNSP & Sport	–	–	–	–	.41	.047
Initial	TRNSP & Assault	.29	.054	–	–	–	–
Initial	Fall & Assault	.32	.003	–	–	–	–
Initial	Assault & Sport	.46	.017	.32	.018	.42	.018
1-month	TRNSP & Sport	–	–	.33	.037	–	–
1-month	Fall & Assault	.34	.043	–	–	–	–
1-month	Assault & Sport	.46	.087	.34	.022	.47	.052
3-month	TRNSP & Sport	.40	.021	.28	.001	.37	.002
3-month	Fall & Assault	.29	.065	–	–	–	–
3-month	Fall & Sport	–	–	.29	.071	.38	.087
3-month	Assault & Sport	.42	.002	.29	.016	.38	.003
6-month	TRNSP & Sport	–	–	.28	.002	.37	.001
6-month	Fall & Sport	–	–	.29	.017	.39	.021
6-month	Assault & Sport	.42	.016	.29	.017	–	–
12-month	TRNSP & Sport	–	–	.31	.001	–	–
12-month	TRNSP & Fall	.28	.051	–	–	–	–
12-month	Fall & Assault	.32	.027	–	–	–	–
12-month	Assault & Sport	.45	.049	.33	.036	–	–
24-month	TRNSP & Fall	.28	.016	.20	.034	–	–
24-month	TRNSP & Sport	–	–	.32	.006	–	–
24-month	Fall & Assault	.33	.002	–	–	–	–
24-month	Assault & Sport	.46	.049	.34	.015	–	–

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

6.3.6 Transport-Related Cause of Injury

Cross-sectional sample. A frequency analysis indicated it was possible to split the transport-related cause of injury group into four groups. Therefore, a further series of one-way between-subjects ANOVAs were conducted at each follow-up assessment, to explore differences in the HADS scores of these four groups (car; motorcycle; bicycle; pedestrian; Table 6.30). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 197 to 399 participants (see Figure 6.1). Table 6.29 displays the mean HADS scores and standard deviations from these analyses. The mean scores were plotted over time for the Anxiety factor (Figure 6.16), Depression factor (Figure C14 – Appendix C), and Psychomotor factor (Figure C15 – Appendix C).

Table 6.29

Descriptive Statistics for Transport-Related Cause of Injury on the HADS Factors – Cross-Sectional Sample

HADS Factor/Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Car	3.56	3.07	3.03	2.84	3.09	3.13
	(2.65)	(2.41)	(2.65)	(2.60)	(2.69)	(2.41)
Motorcycle	2.24	1.64	1.68	1.97	2.20	2.08
	(2.26)	(2.07)	(2.01)	(2.49)	(2.39)	(2.33)
Bicycle	1.70	1.88	1.39	1.23	1.25	2.09
	(2.00)	(2.49)	(1.50)	(1.72)	(1.46)	(1.94)
Pedestrian	2.26	1.72	2.62	2.32	2.46	2.25
	(1.82)	(1.79)	(2.17)	(1.84)	(1.93)	(2.30)
Depression						
Car	1.94	1.72	1.73	1.58	1.87	1.72
	(1.94)	(1.84)	(1.95)	(1.81)	(2.03)	(1.86)
Motorcycle	1.76	1.60	1.34	1.38	1.63	1.22
	(1.75)	(1.99)	(1.61)	(1.81)	(1.93)	(1.71)
Bicycle	1.32	.99	.60	.78	.48	1.04
	(1.76)	(1.43)	(.91)	(1.20)	(.90)	(1.85)
Pedestrian	1.17	.69	1.55	1.70	1.25	1.75
	(1.54)	(1.13)	(1.56)	(2.47)	(1.68)	(1.76)
Psychomotor						
Car	4.10	3.55	3.51	3.52	3.50	3.57
	(2.35)	(2.36)	(2.43)	(2.49)	(2.51)	(2.29)
Motorcycle	4.19	3.50	2.95	2.83	3.05	3.06
	(2.31)	(2.49)	(2.33)	(2.63)	(2.49)	(2.62)
Bicycle	3.08	2.64	2.09	2.41	1.93	2.52
	(2.29)	(2.26)	(1.72)	(2.42)	(1.13)	(1.43)
Pedestrian	3.00	1.79	3.39	2.86	3.15	2.47
	(2.29)	(1.66)	(2.20)	(2.81)	(2.14)	(1.65)

Note. Mean values are displayed with standard deviations presented in parentheses.

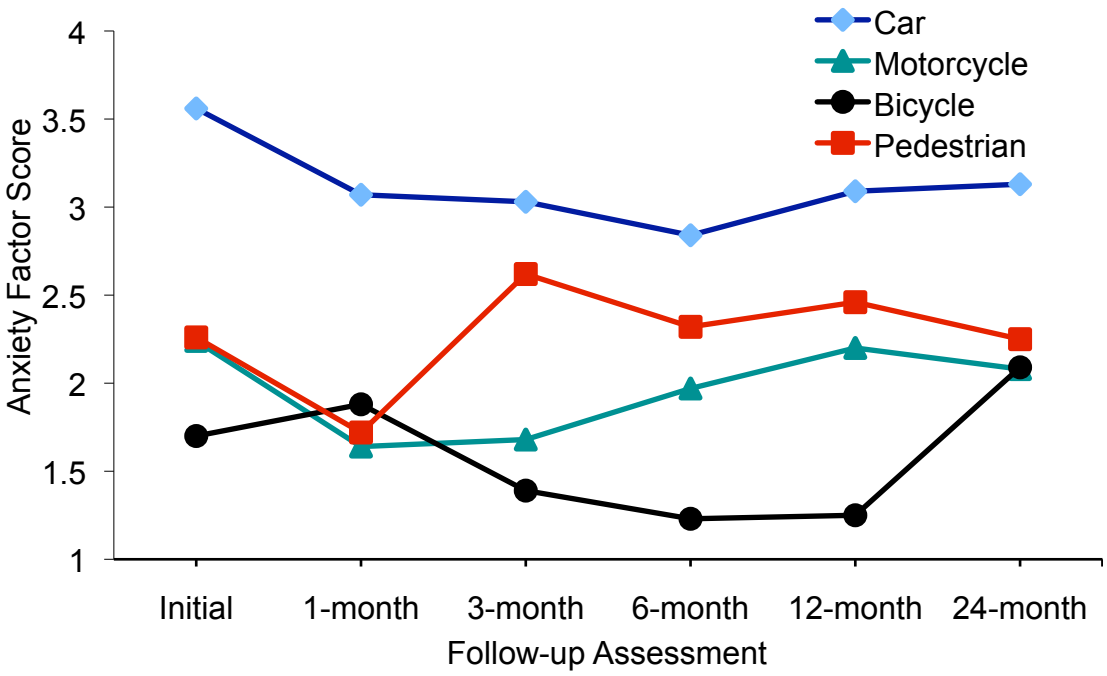

Figure 6.16. Mean anxiety factor scores over time for transport-related cause of injury (cross-sectional sample).

Anxiety factor. Significant differences in mean anxiety scores (Figure 6.16; Table 6.30) were found between the groups at each follow-up ($p < .05$ at 6 months and 24 months; $p < .01$ at 1 month and 12 months; $p < .001$ at the initial and 3-month follow-ups. $\eta^2_{partial}$ showed a medium effect size for differences in mean anxiety scores at the initial, 1-month, and 3-month follow-ups, with small effect sizes at the other follow-ups.

Table 6.31 displays Tukey post-hoc tests performed for each of the HADS factors that were significant or indicated a trend for differences between groups (for the full table of post-hoc comparisons see 'Output – Study 2' in Appendix C on the CD). The car group showed significantly higher mean anxiety scores than the motorcycle group at the initial ($p < .01$), 1-month ($p < .01$), and 3-month ($p < .01$) follow-ups; and a trend for higher mean anxiety scores than the motorcycle group at the 24-month follow-up ($p = .071$). The car group displayed a significantly higher mean anxiety score than the bicycle group at the initial follow-up ($p < .01$), and the 3-month ($p < .05$), 6-month ($p < .05$), and 12-month ($p < .05$) follow-ups (see Figure 6.16).

Depression factor. Significant differences in mean depression scores (Figure C14 – Appendix C; Table 6.30) were found between the groups at the 3-month ($p < .05$) and 12-month ($p < .05$) follow-ups. $\eta^2_{partial}$ indicated small effect sizes. Tukey post-hoc tests (Table 6.31) showed the car group reported a significantly higher mean depression score than the bicycle group at 12-months ($p < .05$), and there was a trend for the car group to show a higher mean depression score than the bicycle group at 3 months (Figure C14)

Psychomotor factor. There was a significant difference in the mean psychomotor scores (Figure C15 – Appendix C; Table 6.30) of the groups at the 12-month follow-up ($p < .05$). A trend was found for the car group to show higher mean psychomotor scores than the bicycle group at the initial ($p = .055$) and 3-month follow-ups ($p = .080$). $\eta^2_{partial}$ indicated small effect sizes. Tukey post-hoc tests (Table 6.31) showed a trend for the car group to report higher mean psychomotor scores than the bicycle group at 3 months ($p = .087$) and 12 months ($p = .079$; Figure C15).

Table 6.30

ANOVA for Transport-Related Cause of Injury on the HADS Factors – Cross-Sectional Sample

Follow-up/ HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Anxiety	3	106	13.15***	< .001	.06	.99
Depression	3	395	1.58	.195	.01	.36
Psychomotor	3	395	2.55	.055	.02	.66
1-month						
Anxiety	3	209	4.66**	.004	.06	.88
Depression	3	209	1.27	.286	.02	.38
Psychomotor	3	209	1.58	.195	.02	.38
3-month						
Anxiety	3	69	8.10***	< .001	.06	.94
Depression	3	73	3.61	.017	.03	.65
Psychomotor	3	255	2.28	.080	.03	.65
6-month						
Anxiety	3	243	3.35*	.020	.04	.77
Depression	3	47	1.09	.361	.01	.23
Psychomotor	3	243	1.83	.143	.02	.44
12-month						
Anxiety	3	97	5.27*	.002	.04	.74
Depression	3	85	3.92*	.011	.03	.59
Psychomotor	3	83	2.98	.036	.03	.59
24-month						
Anxiety	3	193	2.75*	.044	.04	.66
Depression	3	193	1.23	.300	.02	.35
Psychomotor	3	193	1.92	.127	.03	.52

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6.31

Significant/Trend Tukey Post-hoc Tests for Transport-Related Cause of Injury on the HADS Factors – Cross-Sectional Sample

Follow-up	Comparison	Anxiety		Depression		Psychomotor	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial	Car & Motorcycle	.35	.001	–	–	–	–
Initial	Car & Bicycle	.51	.002	–	–	–	–
1-month	Car & Motorcycle	.44	.007	–	–	–	–
3-month	Car & Motorcycle	.41	.006	–	–	–	–
3-month	Car & Bicycle	.63	.045	.46	.073	.60	.087
6-month	Car & Bicycle	.62	.045	–	–	–	–
12-month	Car & Bicycle	.68	.039	–	–	–	–
24-month	Car & Motorcycle	.43	.071	.52	.042	.65	.079

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' cause of injury on HADS scores across 6 time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 93 participants who came to every follow-up assessment and completed the HADS. Four groups were included in the analyses, comprising the most common causes of TBI in the sample: transport ($n = 32$), fall ($n = 28$), assault ($n = 22$), and sport ($n = 11$). Only a small number of participants had other causes of injury and were therefore not included in the analysis. Mean HADS scores and standard deviations are shown in Table 6.32. The mean scores were plotted over time for the Anxiety factor (Figure 6.17), Depression factor (Figure C16 – Appendix C), and Psychomotor factor (Figure 6.18).

Table 6.32

Descriptive Statistics for Cause of Injury on the HADS Factors – Longitudinal Sample

HADS Factor/ Group	Initial (<15 days)	1 month	3 month	6 month	12 month	24 month
Anxiety						
Transport	2.15	1.60	1.79	1.24	1.37	1.89
	(1.99)	(1.74)	(1.95)	(1.46)	(1.48)	(1.85)
Fall	2.13	1.98	1.89	2.03	1.76	2.08
	(2.34)	(1.98)	(2.09)	(2.10)	(1.93)	(2.24)
Assault	3.31	3.15	2.65	2.47	2.82	2.61
	(2.31)	(2.63)	(2.17)	(2.51)	(2.82)	(2.05)
Sport	2.09	1.59	1.30	1.16	1.44	1.38
	(1.71)	(1.66)	(1.34)	(.98)	(1.84)	(1.24)
Depression						
Transport	1.59	1.18	.94	.89	.78	.72
	(1.84)	(1.49)	(1.34)	(1.48)	(1.33)	(1.17)
Fall	1.66	1.34	.99	1.39	1.13	1.26
	(1.93)	(1.56)	(1.43)	(1.50)	(1.36)	(1.76)
Assault	1.90	1.70	1.20	.67	1.38	1.00
	(1.97)	(2.02)	(1.78)	(1.15)	(1.73)	(1.85)
Sport	.94	.71	.49	.32	.06	.21
	(1.67)	(1.16)	(.64)	(.67)	(.21)	(.30)
Psychomotor						
Transport	3.55	2.59	2.40	2.25	2.25	1.99
	(2.16)	(2.39)	(2.34)	(2.03)	(1.78)	(1.61)
Fall	3.02	3.09	2.40	2.60	2.39	2.63
	(1.98)	(2.57)	(1.72)	(1.67)	(2.24)	(2.18)
Assault	4.04	3.92	3.16	2.99	2.93	2.86
	(2.27)	(2.68)	(2.30)	(2.18)	(2.62)	(2.47)
Sport	3.11	1.96	2.15	1.31	1.51	1.90
	(2.09)	(1.64)	(1.60)	(.94)	(1.50)	(1.27)

Note. Mean values are displayed with standard deviations presented in parentheses.

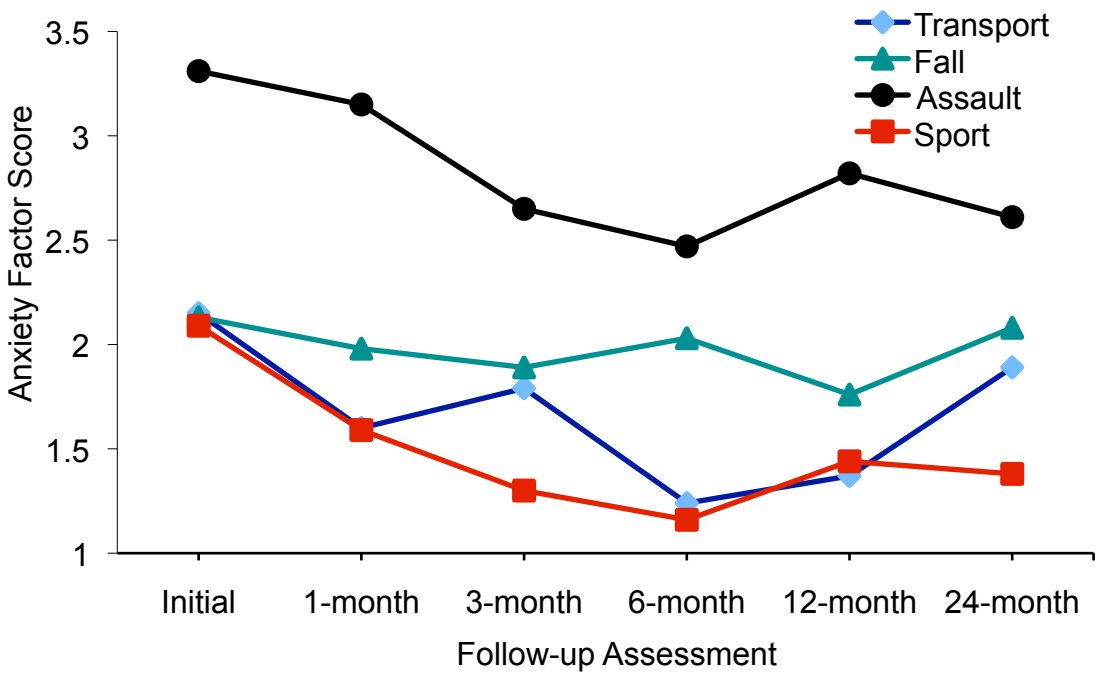

Figure 6.17. Mean anxiety factor scores over time for cause of injury (longitudinal sample).

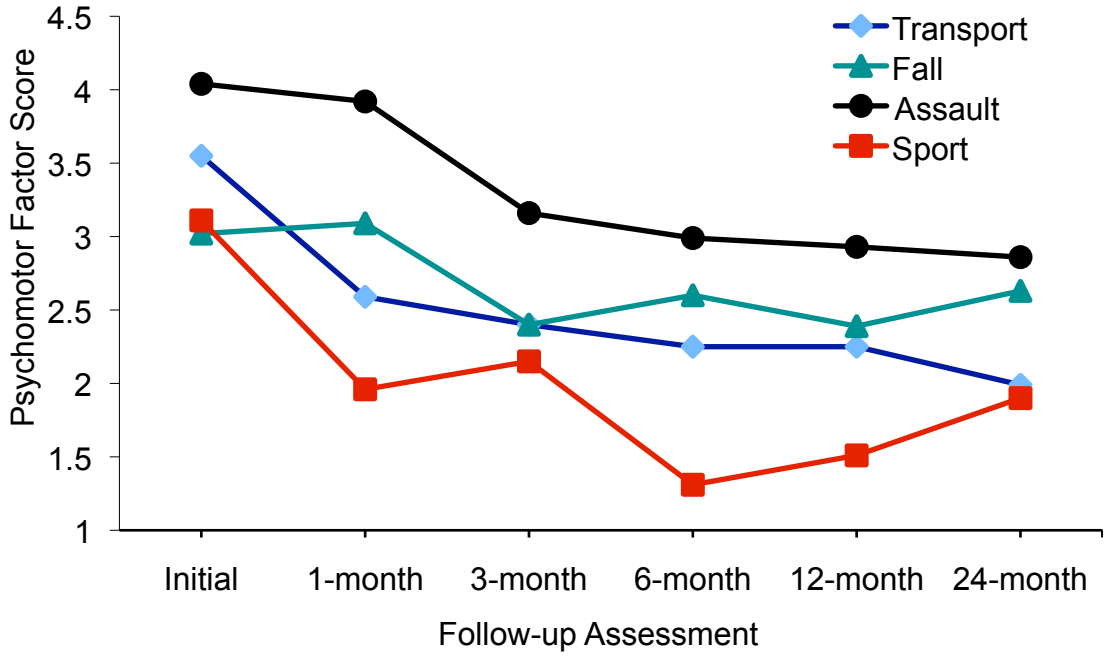

Figure 6.18. Mean psychomotor factor scores over time for cause of injury (longitudinal sample).

Table 6.33 shows the tests of within-subjects effects for cause of injury on the HADS factors. There was a main effect for time on the Anxiety factor, $F(4, 348) = 3.57$, $p = .008$, $\eta^2_{partial} = .04$; Depression factor, $F(3, 305) = 6.34$, $p < .001$, $\eta^2_{partial} = .07$; and the Psychomotor factor, $F(4, 377) = 10.19$, $p < .001$, $\eta^2_{partial} = .10$ (see Figures 6.17, 6.18, and Figure C16). These results indicate a significant reduction in participants' mean HADS scores over time. For the main effect of time, a small effect size was found on the Anxiety factor, and medium effect sizes on the Depression and Psychomotor factors.

Table C9 (Appendix C) shows Bonferroni post-hoc comparisons for time that were significant or indicated a trend for differences between follow-ups (for the full table of post-hoc comparisons see 'Output – Study 2' in Appendix C on the CD). Significant differences in mean anxiety scores (Figure 6.17) were found between the initial and 6-month follow-up ($p = .004$). There was a trend for differences in mean anxiety scores between the initial and 3-month follow-up ($p = .086$), and the initial and 12-month follow-up ($p = .089$). A significant difference in mean depression scores (Figure C16 – Appendix C) was found between the initial and 3-month follow-up ($p = .030$), the initial and 6-month follow-up ($p = .009$), the initial and 12-month follow-up ($p = .041$), the initial and 24-month follow-up ($p = .024$), and the 1-month and 6-month follow-up ($p = .038$). There was a trend for a difference in mean depression scores between the 1-month and 12-month follow-up ($p = .061$). Significant differences in mean psychomotor scores (Figure 6.18) were found between the initial follow-up and: the 3-month ($p = .003$), 6-month ($p < .001$), 12-month ($p < .001$), and 24-month ($p < .001$) follow-ups. There were significant differences in mean psychomotor scores between: the 1-month and 6-month follow-up ($p = .028$), and the 1-month and 12-month follow-ups ($p = .014$).

Tests of between-subjects effects for cause of injury on the HADS factors are displayed in Table 6.33. There was a trend for a main effect comparing the four cause of injury groups

on the Anxiety factor, $F(3, 89) = 2.39$, $p = .074$, $\eta^2_{partial} = .08$, with a medium effect size. The main effect comparing cause of injury was not significant for the Depression factor, $F(3, 89) = 1.56$, $p = .204$, $\eta^2_{partial} = .05$; and Psychomotor factor, $F(3, 89) = 1.61$, $p = .192$, $\eta^2_{partial} = .05$. The Time x Cause of Injury interaction was non-significant for the Anxiety factor, $F(12, 348) = .74$, $p = .705$, $\eta^2_{partial} = .02$; Depression factor, $F(10, 305) = .86$, $p = .577$, $\eta^2_{partial} = .03$; and the Psychomotor factor, $F(13, 377) = .95$, $p = .501$, $\eta^2_{partial} = .03$.

Tukey post-hoc tests for cause of TBI for each of the HADS factors are shown in 'Output – Study 2' (Appendix C on the CD). There was a trend for the assault group to show a higher mean anxiety score than the transport group ($p = .081$).

Table 6.33

Tests of Within-Subjects & Between-Subjects Effects for Cause of Injury on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	348	3.57**	.008	.04	.86
Cause of Injury	3	89	2.39	.074	.08	.58
Time x Cause[a]	12	348	.74	.705	.02	.43
Depression						
Time since TBI[a]	3	305	6.34***	< .001	.07	.98
Cause of Injury	3	89	1.56	.204	.05	.40
Time x Cause[a]	10	305	.86	.577	.03	.46
Psychomotor						
Time since TBI[a]	4	377	10.19***	< .001	.10	1.00
Cause of Injury	3	89	1.61	.192	.05	.41
Time x Cause[a]	13	377	.95	.501	.03	.58

Note. [a]Greenhouse Geisser results are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

6.3.7 Study 2 – Correlations

The relationship between the HADS Anxiety, Depression, and Psychomotor factors, hospitalisation, and severity of TBI (as measured by PTA total) at the initial follow-up assessment was investigating using Pearson product-moment correlation coefficients (Table 6.34). Highly significant ($p < .001$) strong positive correlations were found between each set of the HADS factors. A small correlation was found between hospitalisation (days) and PTA total. Small correlations were found when correlating each of the HADS factors with hospitalisation (days), and when correlating each of the HADS factors with PTA total.

Table 6.34

Means, Standard Deviations and Intercorrelations for HADS Factor Scores and Clinical Variables at the Initial Follow-up

Variable	*M*	*SD*	1	2	3	4	5
1. Anxiety Factor	3.21	2.55	–				
2. Depression Factor	1.63	1.76	.60***	–			
3. Psychomotor Factor	3.90	2.29	.69***	.72***	–		
4. Hospitalisation (days)	2.26	8.04	-.03	-.02	-.01	–	
5. PTA total	.66	1.99	.13**	.15***	.18***	.16***	–

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

6.3.8 Using Initial Clinical Variables to Predict HADS Scores

A series of stepwise multiple regression analyses were conducted to assess the ability of a number of clinical variables measured at the initial follow-up assessment to predict participants' HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI. The predictor variables included in the analyses are listed in Section 6.2.4. Sample sizes varied according to the follow-up assessment and the variable measured (N = 202–280 participants; see 'Output – Study 2' in Appendix C on the CD). Means, standard deviations, and Pearson correlation coefficients for the regression analyses are shown in Table 6.35. All

correlation coefficients were $r < .30$, indicating small relationships when the initial clinical predictor variables PTA (total) and Hospitalisation (days) were correlated with the HADS factors at each follow-up.

Table 6.35

Means, Standard Deviations and Correlations for Initial Clinical Predictor Variables and HADS Factor Scores

Variable	*M*	*SD*	PTA (total)	Hosp (days)
Anxiety				
3-month	2.50	2.42	.07	-.10
6-month	1.99	2.16	.06	-.13*
12-month	2.02	2.16	.19**	-.07
24-month	2.33	2.29	.01	-.10
Depression				
3-month	1.18	1.60	.07	-.02
6-month	1.00	1.51	.09	.00
12-month	1.04	1.56	.17***	.02
24-month	1.88	1.75	.05	.06
Psychomotor				
3-month	2.98	2.23	.03	-.02
6-month	2.57	2.04	.06	-.10*
12-month	2.53	2.14	.15**	-.06
24-month	1.19	1.75	.05	.06

Note. Pearson Correlation Coefficients are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

Each of the stepwise regression analyses is displayed in Table C10 (Appendix C). The final prediction models and the accompanying regression equations are presented in Table 6.36.

Anxiety factor. Three regression models were produced for predicting HADS anxiety scores at 3 months (Table C10 – Appendix C). 'MVA/Assault vs. other TBI causes' was

entered at Step 1, explaining 2% of the variance in anxiety. Hospitalisation (days) was added to the model in Step 2, the total variance explained by the model as a whole was 3%. The final model (Table 6.36) consisted of the predictors 'MVA/Assault vs. other TBI causes,' hospitalisation (days), and PTA total, and explained 4% of the variance in anxiety scores at 3 months (R^2 = .04, F = 3.30 [3, 247], p = .021). Of these three variables, 'MVA/Assault vs. other TBI causes' made the largest unique contribution to the model (β = -.15). Although hospitalisation (days; β = -.11) and PTA (total; β = .10) were included in the model, they did not reach statistical significance (p = .083 and .109 respectively).

Three regression models were produced for predicting HADS anxiety scores at 6 months (Table C10 – Appendix C). Hospitalisation (days) was entered at Step 1, explaining 2% of the variance in anxiety. 'MVA/Assault vs. other TBI causes' was added to the model in Step 2, the total variance explained by the model as a whole was 2%. The final model (Table 6.36) consisted of the predictors hospitalisation (days), 'MVA/Assault vs. other TBI causes,' and 'MVA vs. other TBI causes,' and explained 3% of the variance in anxiety scores at 6 months (R^2 = .03, F = 2.92 [3, 247], p = .035). Of these three variables, 'MVA/Assault vs. other TBI causes' made the largest unique contribution to the model (β = -.17). There was a trend for hospitalisation (days; β = -.11) and 'MVA vs. other TBI causes' (β = .13) to provide a contribution (p = .095 for both variables).

Three regression models were produced for predicting HADS anxiety scores at 12 months (Table C10 – Appendix C). PTA (total) was entered at Step 1, explaining 4% of the variance in anxiety. Hospitalisation (2 groups) was added to the model in Step 2, the total variance explained by the model as a whole was 5%. The final model (Table 6.36) consisted of the predictors PTA (total), hospitalisation (2 groups), and 'MVA/Assault vs. other TBI causes,' and explained 7% of the variance in anxiety scores at 12 months (R^2 = .07, F = 5.11 [3, 212], p = .002). Of these variables, PTA (total) made the largest unique contribution to the

model (β = .19), with hospitalisation (2 groups) also providing a statistically significant contribution (β = -.14). There was a trend for 'MVA/Assault vs. other TBI causes' (β = -.13) to provide a contribution to the model (p = .060).

Two regression models were produced for predicting HADS anxiety scores at 24 months (Table C10 – Appendix C). The best prediction model (Table 6.36) consisted of 'MVA/Assault vs. other TBI causes' explaining 3% of the variance in anxiety (R^2 = .03, F = 5.63 [1, 196], p = .019). Although hospitalisation (days) was included in the model in Step 2 and explained an additional 1% of the variance, it did not reach statistical significance (p = .130).

Depression factor. One regression model was produced for predicting HADS depression scores at 3 months (Table 6.36), with 'MVA vs. other TBI causes' explaining 1% of the variance in depression (R^2 = .01, F = 2.69 [1, 249], p = .102). One regression model (Table 6.36) was produced for predicting HADS depression scores at 6 months, with PTA (2 groups) explaining 1% of the variance in depression (R^2 = .01, F = 2.80 [1, 249], p = .095).

Two regression models were produced for predicting HADS depression scores at 12 months (Table C10 – Appendix C). The best prediction model (Table 6.36) consisted of PTA (total) entered at Step 1, explaining 3% of the variance in depression at 12 months (R^2 = .03, F = 6.39 [1, 214], p = .012). Although TBI cause was included in the model in Step 2 and explained an additional 1% of the variance, it did not reach statistical significance (p = .134). No regression models were produced for predicting HADS depression scores at 24-months.

Psychomotor factor. No regression models were produced for predicting HADS psychomotor scores at 3 months, 6 months, and 24 months. One regression model was produced for predicting HADS psychomotor scores at 12 months (Table 6.36), with PTA (total) explaining 2% of the variance in psychomotor scores (R^2 = .02, F = 5.14 [1, 214], p = .024).

Table 6.36

Final Regression Models for Predicting HADS Factor Scores Using Initial Clinical Variables

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	MVA/Assault vs.	-.70	.30	-.15	-2.33	.021	*Y* = 3.43 + -.70 (MVA/Assault vs.)
	Hosp (days)	-.03	.02	-.11	-1.74	.083	+ -.03 (Hosp days)
	PTA (total)	.15	.09	.10	1.61	.109	+ .15 (PTA total)
	6-months						
	Hosp (days)	-.02	.01	-.11	-1.68	.095	*Y* = 2.04 + -.02 (Hosp days)
	MVA/Assault vs.	-.71	.33	-.17	-2.18	.030	+ -.71 (MVA/Assault)
	MVA vs.	.60	.36	.13	1.68	.095	+ .60 (MVA vs.)
	12-months						
	PTA (total)	.21	.07	.19	2.87	.005	*Y* = 3.52 + .21 (PTA total)
	Hosp (2 groups)	-.62	.30	-.14	-2.09	.038	+ -.62 (Hosp 2 groups)
	MVA/Assault vs.	-.55	.29	-.13	-1.87	.063	+ -.55 (MVA/Assault vs.)
	24-months						
	MVA/Assault vs.	-.78	.33	-.17	-2.37	.019	*Y* = 3.42 + -.78 (MVA/Assault vs.)
Depression	3-months						
	MVA vs.	-.36	.22	-.10	-1.64	.102	*Y* = 1.80 + -.36 (MVA vs.)
	6-months						
	PTA (2 groups)	.38	.23	.11	1.67	.095	*Y* = .95 + .38 (PTA 2 groups)
	12-months						
	PTA (total)	.13	.05	.17	2.53	.012	*Y* = .95 + .13 (PTA total)
Psychomotor	12-months						
	PTA (total)	.17	.07	.15	2.27	.024	*Y* = 2.42 + .17 (PTA total)

6.3.9 Using 1-Month Clinical Variables to Predict HADS Scores

A series of stepwise multiple regression analyses were conducted to assess the ability of a number of demographic variables measured at the 1-month assessment to predict participants' HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-

TBI. The predictor variables included in the analyses are listed in Section 6.2.4. Sample sizes varied according to the follow-up assessment and the variable measured (N = 191–271 participants; see 'Output – Study 2' in Appendix C on the CD).

Means, standard deviations, and Pearson correlation coefficients for the regression analyses are shown in Table 6.37. All correlation coefficients were $r < .30$, indicating small relationships when the 1-month clinical predictor variables PTA (total) and Hospitalisation (days) were correlated with the HADS factors at each follow-up.

Table 6.37

Means, Standard Deviations and Correlations for 1-month Clinical Predictor Variables and HADS Factor Scores

Variable	*M*	*SD*	PTA (total)	Hosp (days)
Anxiety				
3-month	2.39	2.29	.12*	-.08
6-month	2.00	2.19	.03	-.08
12-month	2.00	2.22	.22***	-.03
24-month	2.26	2.34	.15*	-.02
Depression				
3-month	1.15	1.62	.10*	.00
6-month	1.11	1.65	.12*	.00
12-month	1.02	1.57	.21***	.05
24-month	1.19	1.83	.20**	.04
Psychomotor				
3-month	2.95	2.22	.08	-.02
6-month	2.62	2.10	.12*	-.11*
12-month	2.53	2.21	.20**	-.01
24-month	2.71	2.34	.21***	-.02

Note. Pearson Correlation Coefficients are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

Each of the stepwise regression analyses is displayed in (Table C11 – Appendix C). The final prediction models and the accompanying regression equations are presented in Table 6.38.

Anxiety factor. Three regression models were produced for predicting HADS anxiety scores at 3 months (Table C11 – Appendix C). 'MVA/Assault vs. other TBI causes' was entered at Step 1, explaining 2% of the variance in anxiety. PTA (total) was added to the model in Step 2, the total variance explained by the model as a whole was 3%. The final model (Table 6.38) consisted of the predictors 'MVA/Assault vs. other TBI causes,' PTA (total), and hospitalisation (days), and explained 4% of the variance in anxiety scores at 3 months (R^2 = .04, F = 3.42 [3, 242], p = .018). Of these three variables, 'MVA/Assault vs. other TBI causes' made the largest unique contribution to the model (β = -.13). There was a trend for PTA (total; β = .12) to provide a statistically significant contribution (p = .057). Although hospitalisation (days) was included in the model (β = -.10), it did not reach statistical significance (p = .112).

No regression models were produced for predicting HADS anxiety scores at 6 months. Two regression models were produced for predicting HADS anxiety scores at 12 months (Table 6.38). PTA (total) was entered at Step 1, explaining 5% of the variance in anxiety. Hospitalisation (2 groups) was added to the model in Step 2, the total variance explained by the model as a whole was 6% (R^2 = .06, F = 6.43 [2, 207], p = .002). Of the two variables, PTA (total) made the largest unique contribution to the model (β = .24). Although hospitalisation (2 groups) was included in the model (β = -.11), it did not reach statistical significance (p = .112).

Three regression models were produced for predicting HADS anxiety scores at 24 months (Table C11 – Appendix C). 'MVA/Assault vs. other TBI causes' was entered at Step 1, explaining 4% of the variance in anxiety. 'MVA vs. other TBI causes' was added to the

model in Step 2, the total variance explained by the model as a whole was 6%. The final model (Table 6.38) consisted of the predictors 'MVA/Assault vs. other TBI causes,' 'MVA vs. other TBI causes,' and PTA (total), and explained 8% of the variance in anxiety scores at 24 months (R^2 = .08, F = 5.43 [3, 186], p = .001). Of the three variables, 'MVA/Assault vs. other TBI causes' made the largest unique contribution to the model (β = -.30) and 'MVA vs. other TBI causes' also made a statistically significant contribution (β = .20). There was a strong trend for PTA (total; β = .14) to provide a significant contribution to the model (p = .058).

Depression factor. Two regression models were produced for predicting HADS depression scores at 3 months (Table C11 – Appendix C). The best prediction model (Table 6.38) consisted of PTA (total), explaining 1% of the variance in depression at 3 months (R^2 = .01, F = 2.68 [1, 244], p = .103). Although 'MVA/Assault vs. other TBI causes' was included in the model in Step 2 and explained an additional 1% of the variance, it did not reach statistical significance (p = .149).

Two regression models were produced for predicting HADS depression scores at 6 months (Table 6.38). PTA (total) was entered in Step 1, explaining 1% of the variance in depression. Hospitalisation (2 groups) was added to the model in Step 2, the total variance explained by the model as a whole was 3% (R^2 = .03, F = 3.18 [2, 239], p = .043). Of these two variables, PTA (total) made the largest unique contribution to the model (β = .14). There was a trend for hospitalisation (2 groups; β = -12) to provide a significant contribution to the model (p = .082).

Two regression models were produced for predicting HADS depression scores at 12 months (Table 6.38). PTA (total) was entered in Step 1, explaining 4% of the variance in depression. 'MVA/Assault vs. other TBI causes' was added to the model in Step 2, the total variance explained by the model as a whole was 5% (R^2 = .05, F = 5.96 [2, 207], p = .003).

Of these two variables, PTA (total) made the largest unique contribution to the model (β = .20). Although 'MVA/Assault vs. other TBI causes' was included in the model (β = -.11), it did not reach statistical significance (p = .109). One regression model was produced for predicting HADS depression scores at 24 months (Table 6.38), with PTA (total) explaining 4% of the variance in depression (R^2 = .04, F = 7.72 [1, 188], p = .006).

Psychomotor factor. No regression models were produced for predicting HADS psychomotor scores at 3 months. Three regression models were produced for predicting HADS psychomotor scores at 6 months (Table C11 – Appendix C). The best prediction model (Table 6.38) consisted of PTA (total) and hospitalisation (days), explaining 4% of the variance in psychomotor scores (R^2 = .04, F = 4.93 [2, 239], p = .008). Although hospitalisation (2 groups) was included in the model in Step 3 and explained an additional 1% of the variance, it did not reach statistical significance (p = .112).

Two regression models were produced for predicting HADS psychomotor scores at 12 months (Table C11 – Appendix C). The best prediction model (Table 6.38) consisted of PTA (total), explaining 4% of the variance in psychomotor scores (R^2 = 04, F = 8.26 [1, 208], p = .004). Although TBI cause was included in Step 2 and explained an additional 1% of the variance, it did not reach statistical significance (p = .074).

Three regression models were produced for predicting HADS psychomotor scores at 24 month (Table C11 – Appendix C). The best prediction model (Table 6.38) consisted of PTA (total) and 'MVA/Assault vs. other TBI causes,' explaining 7% of the variance in psychomotor at 24 months (R^2 = .07, F = 6.49 [2, 187], p = .002). 'MVA vs. other TBI causes' was included in the model in Step 3 and explained an additional 2% of the variance, but for ease of use, was excluded by the author, as 'MVA/Assault vs. other TBI causes' was already included in the model and made a larger unique contribution.

Table 6.38

Final Regression Models for Predicting HADS Factor Scores Using 1-month Clinical Variables

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	MVA/Assault vs.	-.61	.29	-.13	-2.06	.040	*Y* = 3.23 + -.61 (MVA/Assault vs.)
	PTA (total)	.12	.06	.12	1.91	.057	+ .12 (PTA total)
	Hosp (days)	-.03	.02	-.10	-1.59	.112	+ -.03 (Hosp days)
	12-months						
	PTA (total)	.27	.08	.24	3.50	.001	*Y* = 2.52 + .27 (PTA total)
	Hosp (2 groups)	-.50	.31	-.11	-1.60	.112	+ -.50 (Hosp 2 groups)
	24-months						
	MVA/Assault vs.	-1.44	.42	-.30	-3.39	.001	*Y* = 2.52 + -1.44 (MVA/Assault vs.)
	MVA vs.	.99	.44	.20	2.24	.026	+ .99 (MVA vs.)
	PTA (total)	.18	.09	.14	1.91	.058	+ .18 (PTA total)
Depression	3-months						
	PTA (total)	.07	.04	.10	1.64	.103	*Y* = 1.10 + .07 (PTA total)
	6-months						
	PTA (total)	.12	.05	.14	2.19	.029	*Y* = 1.57 + .12 (PTA total)
	Hosp (2 groups)	-.38	.22	-.12	-1.75	.082	+ -.38 (Hosp 2 groups)
	12-months						
	PTA (total)	.16	.05	.20	2.94	.004	*Y* = 1.41 + .16 (PTA total)
	MVA/Assault vs.	-.35	.21	-.11	-1.61	.109	+ -.35 (MVA/Assault vs.)
	24-months						
	PTA (total)	.20	.07	.20	2.78	.006	*Y* = 1.03 + .20 (PTA total)

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Psychomotor	6-months						
	PTA (total)	.19	.07	.18	2.65	.009	*Y* = 2.61 + .19 (PTA total)
	Hosp (days)	-.04	.02	-.17	-2.49	.013	+ -.04 (Hosp days)
	12-months						
	PTA (total)	.22	.08	.20	2.87	.004	*Y* = 2.38 + .22 (PTA total)
	24-months						
	PTA (total)	.24	.09	.19	2.59	.010	*Y* = 3.51 + .24 (PTA total)
	MVA/Assault vs.	-.69	.34	-.15	-2.04	.042	+ -.69 (MVA/Assault vs.)

6.4 Study 2 - Discussion

Study 2 aimed to examine differences in TBI participants' scores on the HADS based on clinical variables relating to the head injury, including: severity, cause of injury, hospitalisation, and orthopaedic injury. Data for this study was collected at six follow-up assessments over 2 years after participants sustained a TBI. In order to provide a detailed exploration of the relationship between participants' mood outcome and the clinical variables, both longitudinal sample and cross-sectional sample analyses were performed on the data, as well as correlations and multiple regression analyses**.**

6.4.1 Descriptive Statistics

The majority of participants included in Study 2 had mild TBI (72% of the cross-sectional sample; 81% of the longitudinal sample), which is consistent with findings from previous TBI epidemiology studies (Tate et al., 1998). Approximately 40% of participants were hospitalised following TBI and one quarter of participants experienced orthopaedic injury. Consistent with previous research, the present study found high frequencies of transport-related accidents, assaults, and falls in a TBI population (Bruns & Hauser, 2003; O'Connor, 2003).

In the present study approximately one quarter of participants experienced assault and one quarter of participants sustained TBI from fall. Approximately 10% of participants in the study experienced a sporting-related TBI. The most common cause of TBI was transport-related, with over one third of participants sustaining a transport-related injury. Of the transport-related injuries, the majority were car accidents (73%), with motorcycle accidents (16%) being the second highest cause.

6.4.2 Mood Recovery

TBI participants showed a significant reduction in anxiety, depression, and psychomotor HADS scores over time, with lower levels of symptoms reported at 2 years following injury. Overall the results were consistent with Study 1, providing further support that as a clinical group, TBI patients tend to show significant recovery from mood problems over a 2-year period following TBI. The greatest effects were found for reduction in participants' levels of depression and psychomotor symptoms over time. Consistent with Study 1, participants displayed varying patterns of recovery, depending on the HADS factor investigated—providing strong support for the Skilbeck et al. (2011) HADS three-factor model.

There was little difference between the mean HADS depression scores in the present study and the mean HADS depression scores provided by the Dunbar et al. (2000) normative sample. However, participants tended to report comparatively higher anxiety, depression, and psychomotor scores than the normative sample at the earlier follow-up (initial follow-up and 1 month), with little mean differences at later follow-ups. The results suggest the TBI participants in the present study showed early recovery in their depression and psychomotor symptoms, at such a level that they have returned to 'normal'.

6.4.3 Hospitalisation

Little support was found for the hypothesis, *hospitalised TBI patients will exhibit higher HADS factor scores than non-hospitalised TBI patients*. At the initial follow-up assessment, non-hospitalised participants reported significantly higher anxiety scores and showed a trend for higher depression and psychomotor scores, when compared with hospitalised participants. There was a trend for hospitalised participants to report higher depression and psychomotor scores at 12 months and higher depression scores at 24 months, when compared with non-hospitalised participants. No other significant differences or trends were found in participants' HADS scores based on their level of hospitalisation.

Little previous research has examined the relationship between length of hospital stay following TBI and mood. Overall, the findings from the present analyses of hospitalisation showed a small effect size for TBI patients not admitted to hospital to experience heightened symptoms of anxiety soon after injury. TBI patients who are not admitted to hospital may be provided with little information as to possible post-concussion symptoms they may experience. The patient may develop anxiety if these symptoms arise soon after TBI and they are unaware of why these symptoms are occurring and that they are a normal part of recovery. Higher levels of anxiety may subside for these patients as their post-concussion symptoms recover. It is possible other factors may be related to patients' level of hospitalisation (e.g., the amount of pain a patient is in or severity of post-concussion symptoms) and have a bearing upon patients' emotional recovery post-TBI. This will be addressed in Study 4 (Grand Multiple Regression), which will investigate the influence of a wide array of predictor variables (demographic, clinical, and psychological/physiological) on mood following TBI.

6.4.5 PTA

The hypothesis, *TBI patients with more severe PTA would score more highly on the HADS factors* was supported by the cross-sectional sample analyses. In the two-group analyses of PTA, participants with moderate/severe PTA showed significantly higher anxiety scores at 12 months and 24 months, and a strong trend for higher anxiety scores at the initial and 1-month follow-ups, when compared to participants with mild PTA. Participants with moderate/severe PTA reported significantly higher depression scores than mild PTA participants at all follow-ups, with the exception of a strong trend at 3 months. They also showed significantly higher psychomotor scores compared to participants with mild PTA at the initial, 1-month, 12-month, and 24-month follow-ups, with a trend at 6 months.

The four PTA group analyses (No PTA; < 1hr; > 1hr & < 1day; > 1day) also supported the hypotheses. The analyses showed that when compared to participants without PTA, participants with >1day PTA reported significantly higher anxiety scores at 12 months, significantly higher depression scores at the initial, 1-month, 12-months, and 24-month follow-ups, and significantly higher psychomotor scores at the initial, 12-month, and 24-month follow-ups. At 12 months post-injury, participants with >1day PTA reported significantly higher depression scores than participants with '>1hr & < 1day PTA,' and there was a trend for participants with >1day PTA to report higher psychomotor scores than participants with <1hr PTA at the initial follow-up.

The present findings are important as PTA is a sensitive indicator of the severity of brain injury (Shores et al., 1986). The findings from the present analyses showed a small effect size for patients with greater severity of TBI to experience higher levels of anxiety, depression, and psychomotor symptoms compared with mild TBI patients, over 2 years following injury. Patients with mild TBI reported the lowest levels of mood problems and those with severe TBI tended to report the highest level of mood disturbance.

Like previous studies (Fann et al., 2004; McCleary et al., 1998), the present findings suggest a relationship between TBI severity and mood. Moderate and severe TBI patients may experience greater mood disturbance due to difficulty adjusting to more severe changes in their post-injury functioning (e.g., physical, cognitive, behavioural, social, and occupational functioning). The greatest effects for severity were found for differences in participants' depression levels at 1 month and anxiety levels at 3 months, which may be explained by patients difficulty adjusting to early signs of cognitive and physical impairment following moderate/severe TBI.

6.4.6 Orthopaedic Injury

The two-group analyses of orthopaedic injury provided little support for the hypothesis, *TBI patients with greater orthopaedic injury would score more highly on the HADS factors*. There was a trend for participants with orthopaedic injury to show higher mean depression scores at 6 months and higher mean psychomotor scores at 3 months and 12 months, compared with participants without orthopaedic injury. Unexpectedly, at the initial follow-up, participants without orthopaedic injury reported significantly higher mean anxiety scores than participants with orthopaedic injury.

However, three group (no orthopaedic injury; one injury; two or more injuries) and four group (no orthopaedic injury; one orthopaedic injury; two orthopaedic injuries; three or more orthopaedic injuries) analyses of orthopaedic damage supported the hypothesis, and tended to show participants with a greater number of orthopaedic injuries reported significantly higher HADS scores than participants with fewer/no injuries. The three group (no orthopaedic injury; one injury; two or more injuries) and four group (no orthopaedic injury; one orthopaedic injury; two orthopaedic injuries; three or more orthopaedic injuries) analyses based on the severity of orthopaedic injury also supported the hypothesis, with participants

with a greater severity tending to report significantly higher HADS scores from 3 months to 24 months post-TBI.

Overall, the findings from the analyses of orthopaedic injury showed a small effect size for TBI patients with a greater number of orthopaedic injuries to have higher levels of anxiety, depression, and psychomotor symptoms following their injury, post initial follow-up. The findings also suggest TBI patients hospitalised for orthopaedic injury experience higher levels of mood symptomatology than patients without orthopaedic injury and those with more severe orthopaedic damage tend to fare worse in the emotional domain.

These findings are important, as no published research appears to have explored the relationship between orthopaedic injury, TBI, and mood. TBI patients with orthopaedic damage may experience greater changes in mood due to the compounding effect of head injury and the greater physical limitations placed upon the patient by their orthopaedic injuries. A particularly interesting finding at the initial follow-up was for patients without orthopaedic injury to report higher levels of anxiety than patients with two or more severe orthopaedic injuries, and for patients with mild orthopaedic injury to report greater levels of depression and psychomotor symptoms than participants with two or more severe orthopaedic injuries. One explanation may be that patients with orthopaedic injuries are more distracted/preoccupied by physical concerns at this early time period, or are feeling "happy to be alive" early after involvement in a life threatening accident.

6.4.7 Cause of Injury

The hypothesis, *TBI patients whose primary cause of injury was an assault or motor vehicle accident would display higher scores on the HADS factors* was well supported by the cross-sectional sample analyses. In the four-group analyses of cause of injury (MVA; assault; falls; sporting injuries), TBI participants injured from assault tended to report significantly higher HADS scores than participants with TBI caused by sporting injury. TBI participants

injured from assault showed significantly higher anxiety scores than TBI participants injured by fall at the initial, 1-month, 12-month, and 24-month follow-ups, with a trend at 3 months. There was a trend for TBI participants injured from assault to report higher anxiety scores than participants with a transport-related TBI at the initial follow-up.

Participants with transport-related TBI tended to report significantly higher HADS scores across the follow-ups, than participants with TBI caused by sporting injury. Participants with transport-related TBI were also found to have significantly higher depression and psychomotor scores than TBI participants injured by fall at 24-months, and there was a trend for participants with transport-related TBI to show higher anxiety scores than TBI participants injured by fall at 12 months. TBI participants injured by fall reported significantly higher psychomotor scores at 6 months, depression scores at 24 months and showed a trend for higher depression and psychomotor scores at 3 months, when compared to participants with TBI caused by sporting injury.

Overall, the findings from the analyses of cause of injury showed a small effect size for TBI patients injured from assault or a transport-related accident to experience the highest levels of anxiety, depression, and psychomotor symptoms, over 2 years following injury. TBI patients injured from assault consistently showed higher anxiety levels than all other groups and TBI patients that sustained sporting injury had the lowest levels of anxiety, depression, and psychomotor symptoms, over the 2-year post-injury period. No significant difference was found between participants' cause of injury and their PTA scores, which indicates cause of injury and PTA independently had an effect on TBI patients' HADS scores.

The findings of the present study provide greater insight into the relationship between cause of TBI and mood outcome. It has previously been found that TBI patients injured in motor vehicle accidents and assaults reported significantly more emotional symptoms over a 12-month period post-TBI compared to TBI patients with other causes of injury (Cannan,

2006). The present study found TBI patients injured in transport-related accidents and assaults continued to report significantly more emotional symptoms than other groups at 24 months. TBI patients whose primary source of injury is an assault or a transport-related accident may have increased mood disturbance due to the more unexpected and traumatic nature of these types of injury, leading to greater susceptibility to PTSD (Cannan, 2006; Moore et al., 2006). It is likely that patients would experience a greater sense of loss or guilt associated with assaults or motor vehicle accidents, especially if their friends or relatives were involved.

6.4.8 Transport-Related Cause of Injury

Further cross-sectional sample analyses were conducted to examine whether participants' recovery on the HADS differed between the transport-related cause of injury groups (Car, Motorcycle, Bicycle, and Pedestrian). The findings suggest TBI patients injured in car accidents tend to experience greater anxiety and depression after injury, compared to TBI patients injured in other transport-related accidents. TBI patients injured in bicycle-related accidents tended to show the lowest HADS scores of the four transport-related groups. The greatest effects (medium effect size) were found for differences in patients' anxiety levels over the first 3 months following TBI. Perhaps patients with TBI resulting from car accidents showed increased HADS scores due to issues unique to this type of transport-related injury, such as managing car damage, motor vehicle insurance, and possible accident-related court cases.

6.4.9 Longitudinal Sample

The longitudinal sample analyses did not provide any statistically significant results to support the hypotheses, which may be explained by the smaller sample sizes and reduced power when compared to the cross-sectional sample analyses. However, there was a trend for participants with TBI caused by assault to have higher anxiety scores compared to

participants with other causes of TBI, with a medium effect size. Visual inspection of the mean plots indicated a number of similar patterns in mean scores when compared to the cross-sectional analyses. Consistent with the cross-sectional findings, in the longitudinal sample, participants with moderate/severe PTA tended to show higher anxiety scores across the follow-ups and higher depression and psychomotor scores compared to participants with mild PTA, participants with TBI caused by assault tended to show the highest HADS scores and participants with TBI caused by sporting injuries tended to show the lowest HADS scores.

There were some differences in the findings of the longitudinal sample analyses when compared to the cross-sectional analyses. Of note, participants with TBI caused by fall tended to show higher HADS scores than participants with TBI caused by transport-related accidents and sporting injuries, and participants without orthopaedic injury showed higher anxiety scores than participants with orthopaedic injury across the follow-ups. These differences may be due to the unique characteristics of the longitudinal sample (e.g., greater mean age in the longitudinal sample than the cross-sectional sample and falls more commonly sustained by older people; see Table 5.2 – Section 5.3.1).

6.4.10 Normative Data

To determine whether TBI participants experienced greater mood disturbance than a non-clinical population, participants' mean scores on each HADS factor were compared with the related normative HADS score (Dunbar et al., 2000). Visual inspection of the mean HADS scores indicated some large differences when compared with the mean HADS scores reported by Dunbar et al. (2000) normative sample. Hospitalised participants, participants with orthopaedic injury, participants with greater PTA, and participants with TBI caused by assault or a transport-related accident, tended to report higher HADS scores than the normative data.

6.4.11 Correlations

The relationship between participants' HADS scores, number of days hospitalised, and severity of TBI was investigated at the initial follow-up. The correlations did not support the hypotheses for hospitalisation and severity of injury, with small relationships found when correlating the HADS factors with these variables. In addition, a small relationship was found between hospitalisation and severity of injury. However, it is unclear whether these small relationships hold across the later follow-up assessments, or if they relate specifically to the initial follow-up.

6.4.12 Multiple Regression Analyses

In the multiple regression analyses, each of the correlation coefficients between the clinical predictor variables and the HADS factors was small. Although some of these correlations were statistically significant, it is likely this was due to the large sample sizes—rather than indicating meaningful differences (Pallant, 2009).

Using initial clinical variables to predict HADS scores. The regression models predicting participants' HADS scores from clinical variables measured at the initial follow-up were very small accounting for 1–7% of variance explained. Predictors that tended to feature in the models included PTA, hospitalisation, and 'MVA/Assault vs. other TBI causes.' The best regression model was found for predicting participants' anxiety scores at 12 months, with PTA, hospitalisation, and 'MVA/Assault vs. other TBI causes,' explaining 7% of the variance in participants' anxiety scores.

Using 1-month clinical variables to predict HADS scores. The regression models predicting participants' HADS scores from clinical variables measured at the 1-month follow-up also tended to be very small, accounting for 1–9% of variance explained. Predictors that tended to feature in the models included PTA, hospitalisation, and MVA/Assault vs. The best regression models were found for predicting participants' anxiety

and psychomotor scores at 24 months, with the predictors 'MVA/Assault vs. other TBI causes,' 'MVA vs. other TBI causes,' and PTA accounting for 8% of the variance in participants' anxiety scores and 9% of the variance in participants' psychomotor scores. Although these predictors only accounted for a small percentage of the variance in anxiety and psychomotor, these findings are still important, given the prediction of such a late time period following TBI (24 months).

6.4.13 Limitations

The limitations discussed in Study 1 (Chapter 5 – Section 5.4.13) also apply to the present study.

6.5 Summary of Findings From Study 2

Study 2 examined the influence of clinical variables on the emotional outcome of TBI patients over a 2-year post-injury period. The findings suggest TBI patients tend to recover from mood problems over a 2-year time period following TBI. However, over this 2-year period, patients differ in their emotional outcome based upon differences in clinical variables. Higher scores on the HADS were shown by participants with more severe TBI, participants with orthopaedic injury or more severe orthopaedic injury, and participants who sustained TBI from assault or car/motorcycle accidents. TBI patients who are not admitted to hospital may experience heightened symptoms of anxiety soon after injury, with severity of anxiety symptoms then dissipating over time. Many of the effect sizes were small in Study 2, however some medium effect sizes were found at early follow-up assessments for differences in HADS scores according to participants' PTA, orthopaedic injury, and cause of injury.

Across the multiple regression analyses, PTA total, hospitalisation, 'MVA/Assault vs. other TBI causes,' and 'MVA vs. other TBI causes' tended to make statistically significant (or a trend for) unique contributions to the regression models—suggesting these variables may play an important role in predicting HADS anxiety, depression, and psychomotor scores.

A later study (Study 4) will examine whether these clinical variable risk factors can be used in combination with demographic and psychological/physiological variables, to significantly predict TBI patients' HADS factor scores at a number of follow-up assessments following TBI.

In summary, the current findings demonstrated a number of variables associated with the TBI (PTA, hospitalisation, and cause of injury) are associated with and can predict mood outcome up to 2 years post-injury.

Chapter 7

Study 3 - Relationship Between Psychological/Physiological Consequences of TBI and Mood

As discussed in Chapter 2, a number of variables relating to the psychological/ physiological consequences of head injury have been suggested to influence mood outcome following TBI. Study 3 aimed to examine differences in TBI participants' scores on the HADS based on the psychological/physiological consequences of head injury: pain, fatigue, quality of life, and post-concussion symptoms.

7.1 Hypotheses

1) *Pain and Fatigue:* Higher pain and fatigue ratings will relate to HADS factor scores (Chapter 2 – Sections 2.3.1 and 2.3.2).
2) *Post-concussion symptoms:* TBI patients with higher scores on the RPQ will have higher HADS factor scores (Chapter 2 – Section 2.3.3).
3) *Quality of Life:* TBI patients who score lower on the QOLI will have higher HADS factor scores (Chapter 2 – Section 2.3.4).
4) *Multiple Regression:* Multiple regression will be performed to identify which psychological/physiological variables measured at the initial and 1-month follow-up will significantly predict the HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI (Chapter 2 – Section 2.4).

7.2 Method

7.2.1 Participants. The total sample for Study 3 consisted of 1,044 participants (aged 16–91 years) who completed the HADS following a TBI (see Chapter 5 – Section 5.2.1 for more information). The numbers of participants varied in each analysis (N = 170–587) and are shown in Figure 7.1.

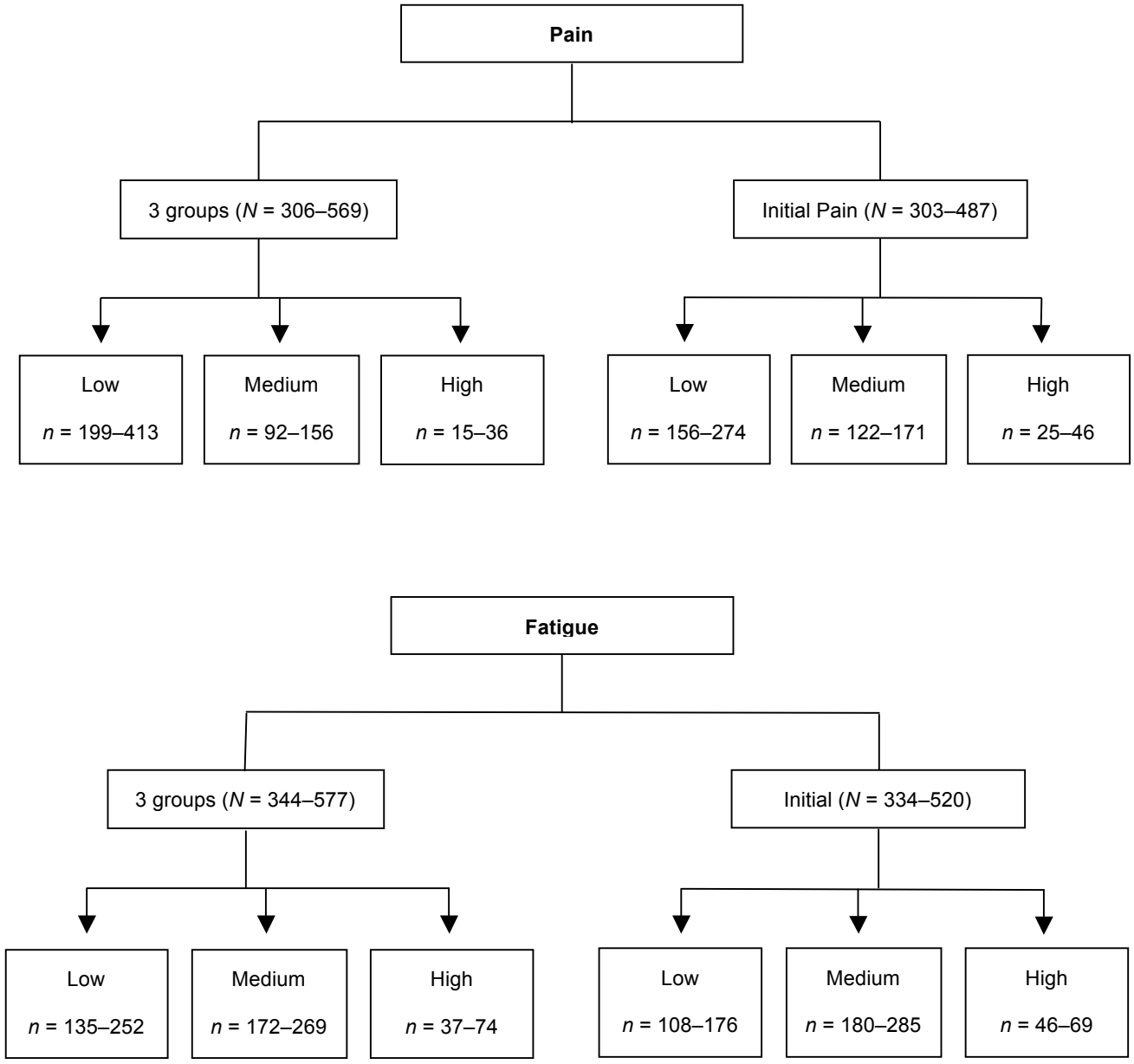

Figure 7.1. Participant numbers for the cross-sectional sample analyses reported in Study 3.

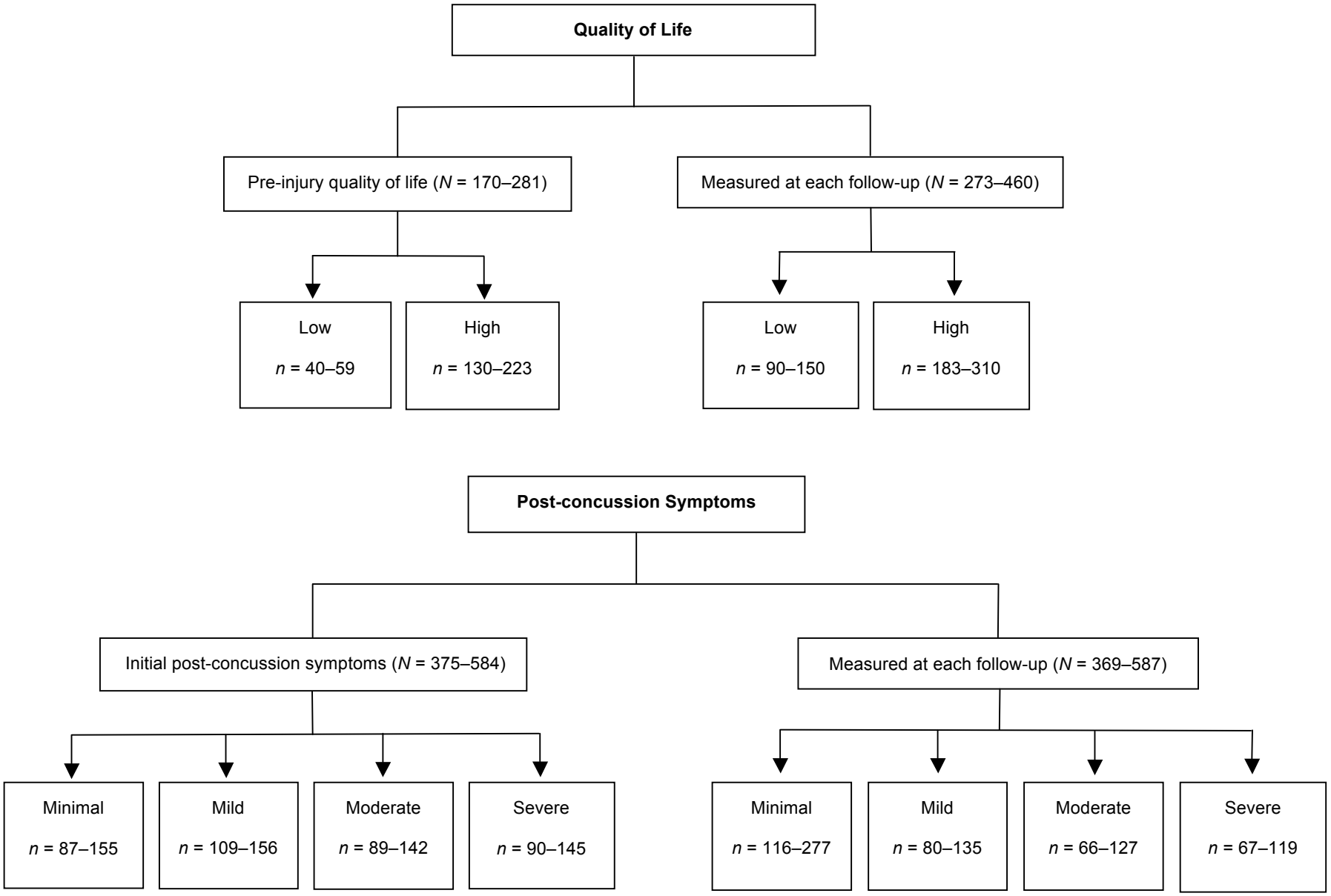

Figure 7.1. Continued.

7.2.2 Materials. At each assessment participants completed the Neuro Trauma assessment, a battery of neuropsychological tests and questionnaires, which included the HADS (Zigmond & Snaith, 1983), the Visual Analogue Scale for Pain and Fatigue (VAS-P, VAS-F; Hayes & Patterson, 1921), the Rivermead Post-Concussion Symptoms Questionnaire (RPQ; King et al., 1995), and the Quality of Life Inventory (QOLI; Frisch et al., 1992).

The VAS is commonly used in health outcome studies to measure pain and other variables (Kersten, Küçükdeveci, & Tennant, 2012). The VAS-P and VAS-F measure pain and fatigue on an ordinal scale from 0–10, with 0 being no fatigue/no pain and 10 being most fatigued/most pain (Kersten, Küçükdeveci, & Tennant, 2012).

The RPQ is a measure of post-concussion symptoms following head injury (King et al., 1995). The questionnaire asks the participant about their change in experience of 16 commonly reported post-concussion symptoms (e.g., headaches and dizziness) on a scale from 0 to 4, ranging from absent to severe.

The QOLI (Frisch, 1992) is a measure of an individual's satisfaction in 16 areas of life such as love, work, and play. The instrument is divided into questions relating to importance (scored on a 3-point rating scale: *Not Important* = 0, *Important* = 1, *Extremely Important* = 2) and questions pertaining to satisfaction (scored on a 6-point rating scale: -3 to +3, very, somewhat, a little dissatisfied or satisfied).

7.2.3 Procedure. The procedure was identical to Studies 1 and 2.

7.2.4 Design. A mixed between-within subjects design, and a between-subjects design was employed. The between-subjects independent variables were pain, fatigue, RPQ score, and QOLI score. The within-subjects independent variable was time since TBI. The Anxiety, Depression, and Psychomotor HADS factor scores were the dependent variables.

A multiple regression design was also employed to examine whether psychological/physiological variables at the initial and 1-month follow-up assessments could

be used to predict mood outcome at the 3-, 6-, 12-, and 24-month follow-ups. As the multiple regression analyses in the present study were exploratory, different variants of the variables were included in the analyses (e.g., pain total score and pain 3 groups). The independent variables (predictor variables) are listed below. The HADS Anxiety, Depression, and Psychomotor raw factor scores were the dependent variables (outcome variables).

Psychological/Physiological Predictor Variables:

- Pain total score (0–10)
- Pain 3 groups (Low [0–3]; Medium [4–6]; High [7–10])
- Fatigue total score (0–10)
- Fatigue 3 groups (Low [0–3]; Medium [4–6]; High [7–10])
- QOLI total score (- 6.0 to + 6.0)
- QOLI 2 groups (Low SQOL [QOLI score < = 1.80]; High SQOL [QOLI score > 1.80])
- QOLI 4 groups (Very Low SQOL [QOLI score < = 1.00]; Low SQOL [QOLI score = 1.10–1.81]; Average SQOL [QOLI score = 1.82–2.25]; High SQOL [QOLI score > 2.25])
- RPQ total score (0–64)
- RPQ 4 groups (Minimal [RPQ score of 0–8]; Mild [RPQ score of 9–17]; Moderate [RPQ score of 18–27]; Severe [RPQ score of 28+])

7.2.5 Data analysis. Data screening and analysis was identical to Studies 1 and 2. Two types of analyses were conducted to compare groups' HADS scores using IBM SPSS Statistics version 20.0: *Longitudinal sample* (*N* = 80–100; repeated measures analysis of variance [ANOVAs] on the data of the participants who attended every follow-up), to assess change/recovery in mood over 24 months post-TBI; *Cross-sectional sample* (*N* = 170–587; independent samples *t*-tests/one-way ANOVAS on the data of all participants attending a

specific follow-up point [e.g., initial follow-up assessment]). When power and effect sizes were not provided by SPSS, these were calculated using the statistical program G*Power Version 3.1.5.1 (Erdfelder et al., 1996). The analyses were performed using the independent variables, the HADS factor scores, and the time periods post-injury.

The assumptions were tested for each of the statistical analyses in the same manner as Study 1 and 2. To examine the relationship between the predictor variables and the dependent variables, preliminary regression analyses involved entering all predictor variables into the equation. Stepwise regression was then conducted where variables were selected based upon mathematical criteria (Tabachnick & Fidell, 2000). Probability of .15 for entry was chosen (Bendel & Afifi, 1977 cited in Tabachnick & Fidell, 2000).

7.3 Results

7.3.1 Descriptive Statistics

Table 7.1 displays means, medians, standard deviations, percentages, and ranges for the psychological/physiological variables in the cross-sectional (i.e., total sample – participants who were found to have a HADS score at one of the assessments) and longitudinal samples. As shown in Table 7.1, similar descriptive statistics were found for both samples, with the main difference being the mean RPQ total score was in the moderate range for the cross-sectional sample, compared with the mild range for the longitudinal sample. In both the cross-sectional and longitudinal samples, the majority of participants reported low pain (approximately 50%) and medium fatigue (approximately 50%). There was very little difference between participants pre-injury and initial follow-up mean SQOL.

Table 7.1

Descriptive Statistics for Psychological/Physiological Variables

Characteristic	*Mdn*/%	*M*	*SD*	Range
Cross-sectional Sample				
Pain	3.00	3.63	2.72	0–10
Low Pain	52%			
Medium Pain	39%			
High Pain	9%			
Fatigue	5.00	4.86	2.54	0–10
Low Fatigue	30%			
Medium Fatigue	55%			
High Fatigue	15%			
RPQ	18.00	19.60	13.07	0–58
Pre-injury SQOL	3.03	2.81	1.52	
Initial SQOL	2.56	2.27	1.78	
Longitudinal Sample				
Pain	3.00	3.73	2.58	1–9
Low Pain	52%			
Medium Pain	41%			
High Pain	7%			
Fatigue	5.00	4.58	2.47	1–9
Low Fatigue	37%			
Medium Fatigue	51%			
High Fatigue	12%			
RPQ	16.00	17.08	11.30	1–48
Pre-injury SQOL	3.29	3.13	1.20	
Initial SQOL	2.78	2.60	1.63	

7.3.2 Pain

Cross-sectional sample. One-way between-subjects ANOVAs were conducted at each follow-up to compare participants' HADS scores based on their level of pain (Table 7.2). Three groups were included in the analyses, based upon McCaffery and Beebe (1993; low pain [VAS-P = 0–3], medium pain [VAS-P = 4–6], and high pain [VAS-P = 7–10]). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 306 to 569 participants: low pain (*n* = 199–413), medium pain (*n* = 92 – 156), and high pain (*n* = 15–35; see Figure 7.1). Table D1 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figures 7.2, 7.3, and 7.4.

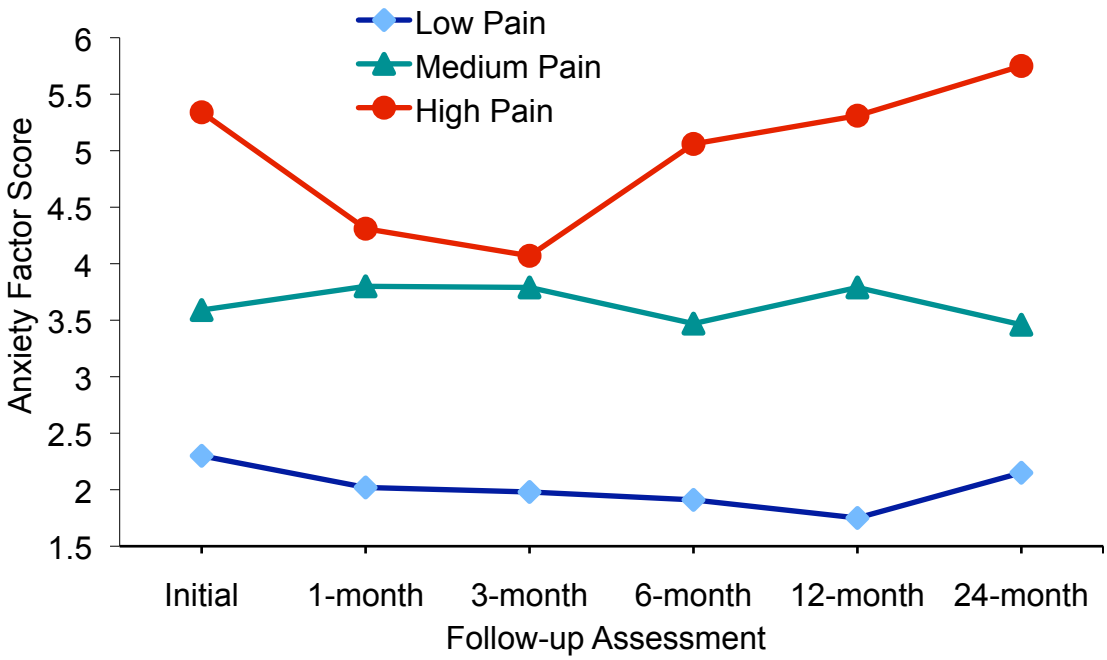

Figure 7.2. Mean anxiety factor scores over time for pain (cross-sectional sample).

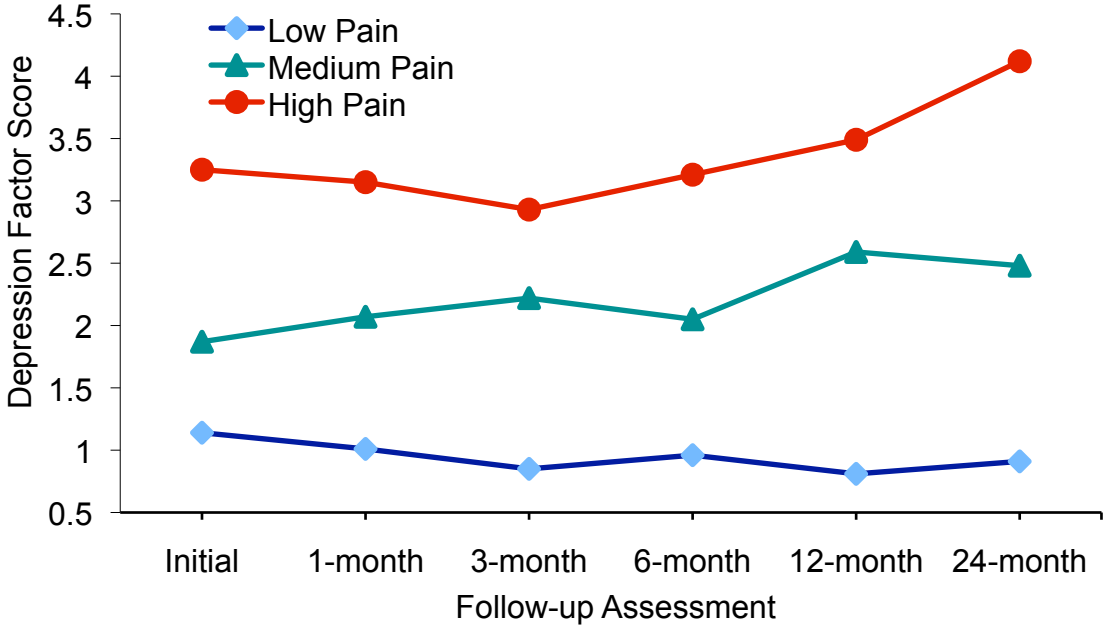

Figure 7.3. Mean depression scores over time for pain (cross-sectional sample).

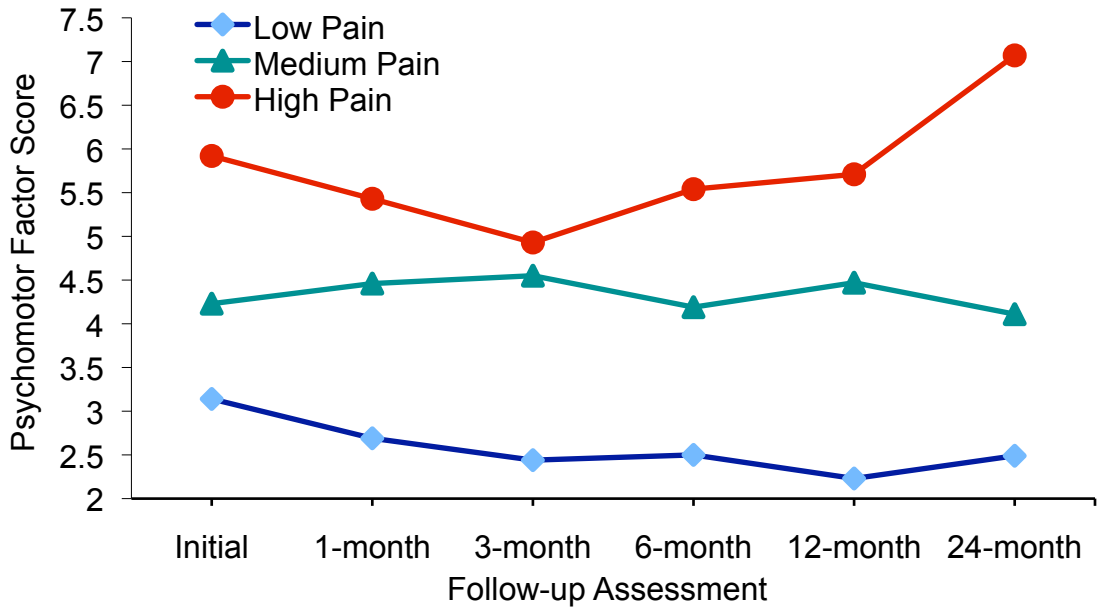

Figure 7.4. Mean psychomotor factor scores over time for pain (cross-sectional).

Anxiety factor. Highly significant differences in mean anxiety scores (Figure 7.2; Table 7.2) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ showed a large effect size at the initial and 1-month follow-ups, and medium effect sizes at the other follow-ups.

Significant Tukey post-hoc tests for each HADS factor are displayed in Table 7.3 (for the full table of post-hoc comparisons see 'Output – Study 3' in Appendix D on the CD). The high pain group reported significantly higher mean anxiety scores than the low pain group at each follow-up ($p < .001$). The high pain group showed significantly higher mean anxiety scores than the medium pain group at the initial ($p < .001$), 6-month ($p < .01$), 12-month ($p < .001$), and 24-month ($p < .001$) follow-ups. The medium pain group displayed significantly higher mean anxiety scores ($p < .001$) than the low pain group at each follow-up.

Depression factor. Highly significant differences in mean depression scores (Figure 7.3: Table 7.2) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ showed large effect sizes at the 3-month, 12-month, and 24-month follow-ups, and medium effect sizes at the initial, 1-month, and 6-month follow-ups.

Tukey post-hoc tests (Table 7.3) showed the high pain group reported significantly higher mean depression scores than the low pain group at each follow-up ($p < .001$). The high pain group showed significantly higher mean depression scores than the medium pain group at each follow-up. ($p < .05$ at 1 month and 3 months; $p < .01$ at 6 months and 12 months; $p < .001$ at the initial and 24-month follow-ups). The medium pain group displayed significantly higher mean anxiety scores ($p < .001$) than the low pain group at each follow-up.

Psychomotor factor. Highly significant differences in mean psychomotor scores (Figure 7.4; Table 7.2) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ showed a medium effect size at the initial follow-up and large effect sizes at the other follow-ups.

Tukey post-hoc tests (Table 7.3) showed the high pain group reported significantly higher mean psychomotor scores than the low pain group at each follow-up ($p < .001$). The high pain group showed significantly higher mean psychomotor scores than the medium pain group at the initial ($p < .001$), 3-month ($p < .001$), 6-month ($p < .01$), 12-month ($p < .01$), and 24-month ($p < .001$) follow-ups. The medium pain group displayed significantly higher mean psychomotor scores ($p < .001$) than the low pain group at each follow-up.

Table 7.2

ANOVA for Pain on the HADS Factors – Cross-Sectional Sample

Follow-up/HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Anxiety	2	98	24.99***	< .001	.14	1.00
Depression	2	79	19.61***	< .001	.12	1.00
Psychomotor	2	97	24.00***	< .001	.13	1.00
1-month						
Anxiety	2	30	15.15***	< .001	.15	1.00
Depression	2	29	11.26***	< .001	.13	1.00
Psychomotor	2	303	27.46***	< .001	.15	1.00
3-month						
Anxiety	2	94	26.45***	< .001	.13	1.00
Depression	2	81	32.34***	< .001	.19	1.00
Psychomotor	2	75	44.14***	< .001	.21	1.00
6-month						
Anxiety	2	63	27.58***	< .001	.13	1.00
Depression	2	58	24.46***	< .001	.13	1.00
Psychomotor	2	70	35.40***	< .001	.15	1.00
12-month						
Anxiety	2	132	53.41***	< .001	.12	1.00
Depression	2	103	56.36***	< .001	.15	1.00
Psychomotor	2	124	69.40***	< .001	.15	1.00
24-month						
Anxiety	2	44	20.53***	< .001	.11	1.00
Depression	2	31	27.18***	< .001	.20	1.00
Psychomotor	2	38	33.07***	< .001	.18	1.00

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.3

Significant Tukey Post-hoc Tests for Pain on the HADS Factors – Cross-Sectional Sample

Follow-up	Pain Comparison	Anxiety		Depression		Psychomotor	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial	Low & Medium	.25	< .001	.18	< .001	.23	< .001
Initial	Low & High	.43	< .001	.30	< .001	.39	< .001
Initial	Medium & High	.44	< .001	.31	< .001	.40	< .001
1-month	Low & Medium	.27	< .001	.20	< .001	.28	< .001
1-month	Low & High	.57	< .001	.43	< .001	.59	< .001
1-month	Medium & High	–	–	.45	.044	–	–
3-month	Low & Medium	.23	< .001	.16	< .001	.20	< .001
3-month	Low & High	.39	< .001	.26	< .001	.34	< .001
3-month	Medium & High	–	–	.29	.036	–	–
6-month	Low & Medium	.22	< .001	.16	< .001	.21	< .001
6-month	Low & High	.44	< .001	.31	< .001	.42	< .001
6-month	Medium & High	.47	.002	.33	.002	.45	.008
12-month	Low & Medium	.23	< .001	.16	< .001	.21	< .001
12-month	Low & High	.41	< .001	.29	< .001	.37	< .001
12-month	Medium & High	.44	.002	.31	.010	.40	.006
24-month	Low & Medium	.26	< .001	.18	< .001	.24	< .001
24-month	Low & High	.60	< .001	.42	< .001	.55	< .001
24-month	Medium & High	.63	.001	.44	.001	.58	< .001

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

7.3.3 Initial Pain

Cross-sectional sample. One-way between-subjects ANOVAs were conducted at each follow-up assessment to compare participants' HADS scores based upon their level of pain measured at the initial follow-up (Table 7.4). Three initial pain groups were included in the analyses: low pain (VAS-P = 0–3), medium pain (VAS-P = 4–6), and high pain (VAS-P = 7–10). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 303 to 487 participants: low pain (*n* = 156–274), medium pain (*n* = 122–171), and high pain (*n* = 25–46; see Figure 7.1). Table D2 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figures 7.5, 7.6, and 7.7.

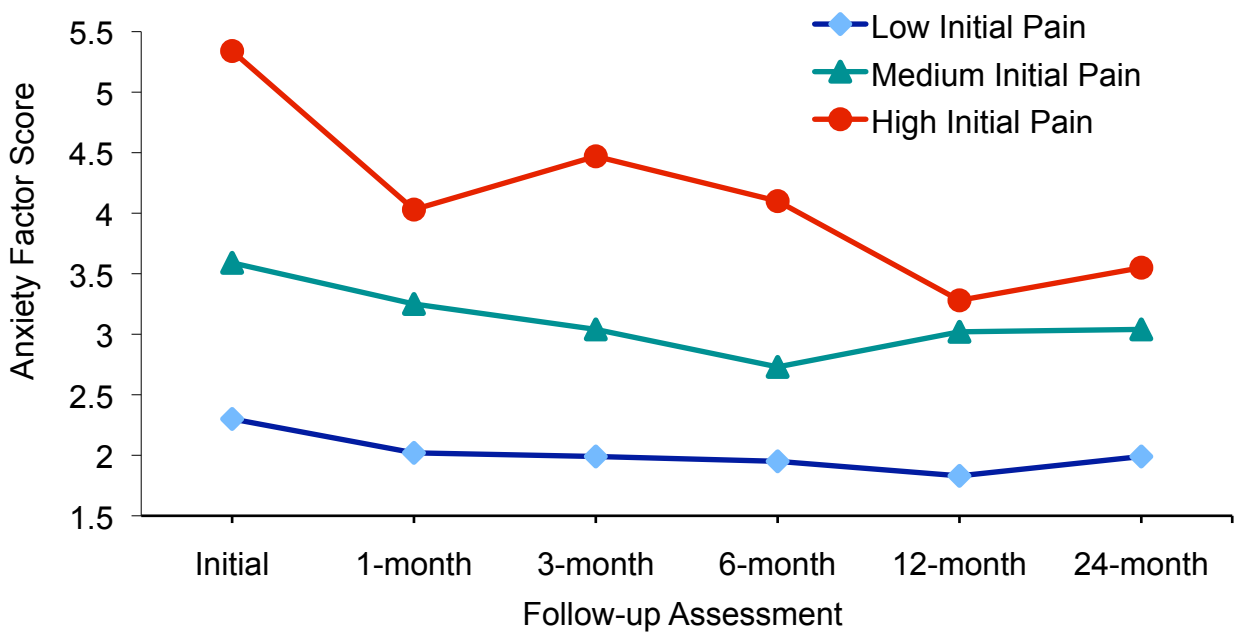

Figure 7.5. Mean anxiety factor scores over time for initial pain (cross-sectional sample).

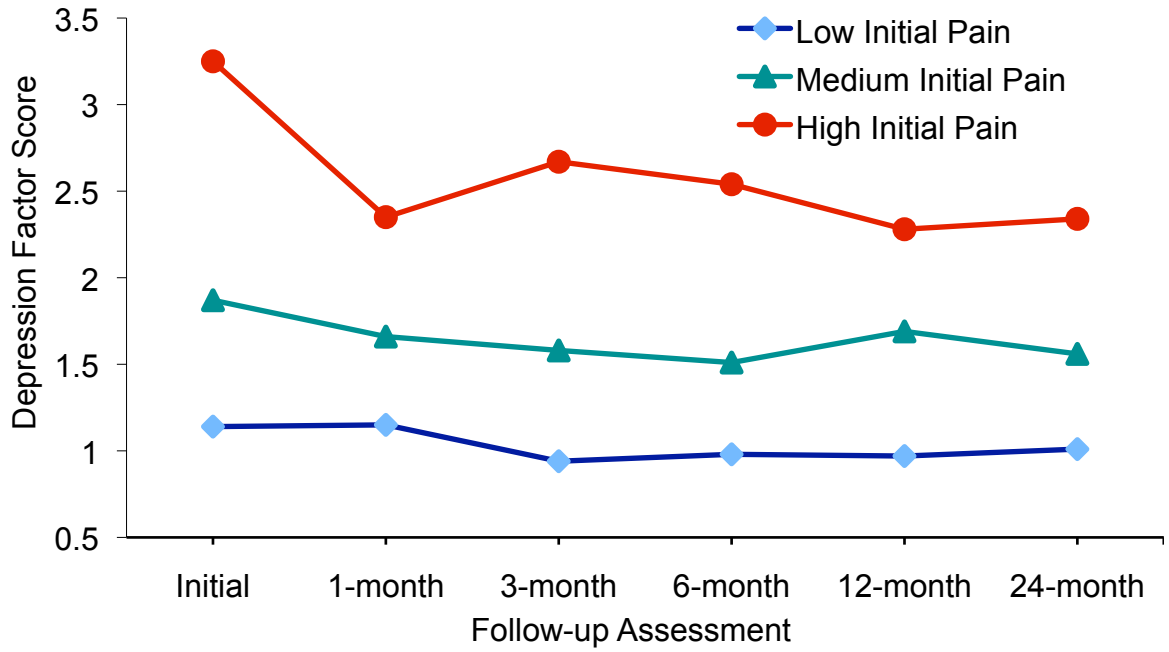

Figure 7.6. Mean depression scores over time for initial pain (cross-sectional sample).

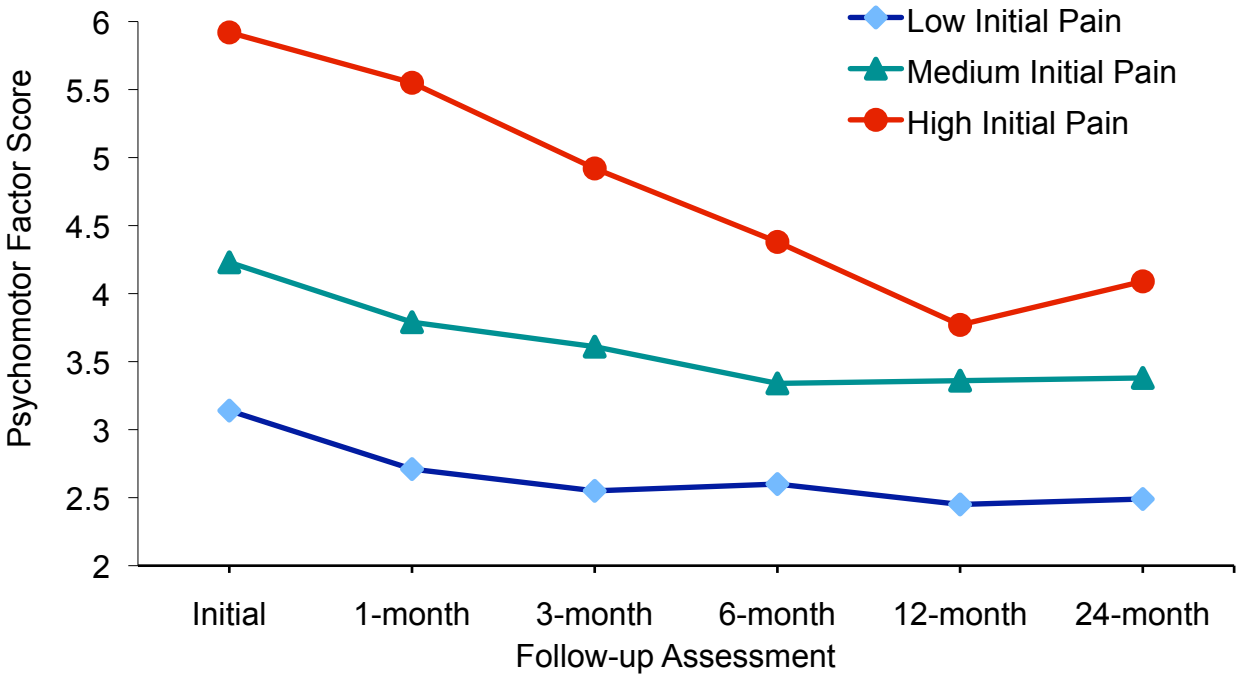

Figure 7.7. Mean psychomotor factor scores over time for initial pain (cross-sectional sample).

Anxiety factor. Highly significant differences in mean anxiety scores (Figure 7.5; Table 7.4) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated a large effect size at the initial follow-up and medium effect sizes at all other follow-ups.

Significant Tukey post-hoc tests for each of the HADS factors are displayed in Table 7.5 (for the full table of post-hoc comparisons see 'Output – Study 3' in Appendix D on the CD). The high pain group showed significantly higher mean anxiety scores than the low pain group at each follow-up ($p < .01$ at 12 months; $p < .001$ at all other follow-ups). The high pain group reported significantly higher mean anxiety scores than the medium pain group at the initial, 3-month, and 6-month follow-ups ($p < .001$). The medium pain group showed significantly higher mean anxiety scores than the low pain group at each follow-up ($p < .01$ at 6 months; $p < .001$ at all other follow-ups; Figure 7.5).

Depression factor. Highly significant differences in mean depression scores (Figure 7.6; Table 7.4) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ showed small effect sizes at 1 month and 24 months, medium effect sizes at 3 months, 6 months, and 12 months, and a large effect size at the initial follow-up.

Tukey post-hoc tests (Table 7.5) showed the high pain group reported significantly higher mean depression scores than the low pain group at each follow-up ($p < .01$ at 1 month; $p < .001$ at all other follow-ups). The high pain group showed significantly higher mean depression scores than the medium pain group at the initial ($p < .001$), 3-month ($p < .001$), 6-month ($p < .001$), and 24-month ($p < .05$) follow-ups. The medium pain group reported significantly higher mean depression scores than the low pain group at each follow-up ($p < .05$ at 1 month and 24 months, $p < .01$ at 6 months; $p < .001$ at the initial, 3-month, and 12-month follow-ups; Figure 7.6).

Psychomotor factor. Highly significant differences in mean psychomotor scores (Figure 7.7; Table 7.4) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$

showed medium effect sizes at the initial, 1-month, and 3-month follow-ups and small effect sizes at the other follow-ups.

Tukey post-hoc tests (Table 7.5) showed the high pain group reported significantly higher mean psychomotor scores than the low pain group at each follow-up ($p < .01$ at 12-months; $p < .001$ at all other follow-ups). The high pain group displayed significantly higher mean psychomotor scores than the medium pain group at the initial ($p < .001$), 1-month ($p < .001$), 3-month ($p < .001$), and 6-month follow-ups ($p < .05$), with no significant differences in mean psychomotor scores between the groups at 12 months and 24 months ($p > .05$). The medium pain group showed significantly higher mean psychomotor scores than the low pain group at each follow-up ($p < .01$ at 6 months; $p < .001$ at all other follow-ups; Figure 7.7).

Table 7.4

ANOVA for Initial Pain on the HADS Factors – Cross-Sectional Sample

Follow-up/ HADS Factor	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
Initial (<15 days)						
Anxiety	2	98	24.99***	.14	< .001	1.00
Depression	2	79	79.29***	.12	< .001	1.00
Psychomotor	2	97	97.12***	.13	< .001	1.00
1-month						
Anxiety	2	70	12.66***	.10	< .001	1.00
Depression	2	63	4.97***	.04	.001	.90
Psychomotor	2	104	19.56***	.12	< .001	1.00
3-month						
Anxiety	2	117	19.96***	.10	< .001	1.00
Depression	2	108	18.56***	.10	< .001	1.00
Psychomotor	2	108	22.03***	.11	< .001	1.00
6-month						
Anxiety	2	119	14.69***	.08	< .001	1.00
Depression	2	110	14.83***	.08	< .001	1.00
Psychomotor	2	126	11.98***	.06	< .001	1.00
12-month						
Anxiety	2	122	11.77***	.06	< .001	1.00
Depression	2	110	10.91***	.06	< .001	1.00
Psychomotor	2	112	8.58***	.05	< .001	1.00
24-month						
Anxiety	2	119	10.70***	.06	< .001	1.00
Depression	2	96	8.00***	.05	< .001	1.00
Psychomotor	2	115	10.13***	.06	< .001	1.00

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.5

Significant Tukey Post-hoc Tests for Initial Pain on the HADS Factors – Cross-Sectional Sample

Follow-up	Initial Pain Comparison	Anxiety		Depression		Psychomotor	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial	Low & Medium	.25	< .001	.18	< .001	.23	< .001
Initial	Low & High	.43	< .001	.30	< .001	.39	< .001
Initial	Medium & High	.44	< .001	.31	< .001	.40	< .001
1-month	Low & Medium	.26	< .001	.21	.041	.27	< .001
1-month	Low & High	.47	< .001	.37	.004	.49	< .001
1-month	Medium & High	–	–	–	–	.50	.001
3-month	Low & Medium	.23	< .001	.16	< .001	.21	< .001
3-month	Low & High	.38	< .001	.26	< .001	.34	< .001
3-month	Medium & High	.39	.001	.27	< .001	.36	.001
6-month	Low & Medium	.22	.002	.16	.002	.22	.002
6-month	Low & High	.37	< .001	.26	< .001	.36	< .001
6-month	Medium & High	.38	.001	.27	< .001	.37	.016
12-month	Low & Medium	.25	< .001	.18	< .001	.23	< .001
12-month	Low & High	.42	.002	.30	< .001	.39	.002
24-month	Low & Medium	.26	< .001	.19	.012	.24	.001
24-month	Low & High	.41	< .001	.31	< .001	.39	< .001
24-month	Medium & High	–	–	.32	.044	–	–

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' pain level on HADS scores across six time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 92 participants who completed the VAS-P at the initial follow-up and the HADS at every follow-up assessment. Three groups were included in the analyses, low pain (n = 48), medium pain (n = 38), and high pain (n = 6). These groups were categorized based upon McCaffery and Beebe (1993; low pain [VAS-P = 0–3], medium pain [VAS-P = 4–6], and high pain [VAS-P = 7–10]). Mean HADS factor scores and standard deviations are shown in Table D3 (Appendix D).

Table 7.6 shows the tests of within-subjects for pain on the HADS factors. There was a trend for a main effect for time since TBI on the Anxiety factor, $F(4, 341) = 2.26$, $p = .066$, $\eta^2_{\text{partial}} = .03$; and on the Depression factor, $F(3, 309) = 2.38$, $p = .060$, $\eta^2_{\text{partial}} = .03$. A significant main effect for time since TBI was found on the Psychomotor factor, $F(4, 373) = 5.52$, $p < .001$, $\eta^2_{\text{partial}} = .06$. These results indicate a reduction in participants' mean HADS scores over time. For the main effect of time, small effect sizes were found on the Anxiety and Depression factors, and a medium effect size on the Psychomotor factor.

Bonferroni post-hoc comparisons for time since TBI, for each of the HADS factors are displayed in 'Output – Study 3' (Appendix D on the CD). Table D4 (Appendix D) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. There was a significant difference in mean anxiety scores between the 3-month and 6-month follow-up (p = .033). Significant differences in mean psychomotor scores were found between the initial and 6-month follow-up (p = .003), the initial and 12-month follow-up (p = .048), the 1-month and 6-month follow-up (p = .002), and the 1-month and 12-month follow-up (p = .006). There was a trend for a difference in mean psychomotor scores between

the 3-month and 6-month follow-up ($p = .077$). No significant differences in mean depression scores were found between the follow-up assessments ($p > .05$).

Tests of between-subjects effects for pain on the HADS factors are displayed in Table 7.6. The main effect comparing the three pain groups was significant for the Anxiety factor, $F(2, 89) = 10.73$, $p < .001$, $\eta^2_{partial} = .19$; Depression factor, $F(3, 309) = 2.38$, $p = .003$, $\eta^2_{partial} = .12$; and Psychomotor factor, $F(2, 89) = 12.64$, $p < .001$, $\eta^2_{partial} = .22$. For the main effect of pain, large effect sizes were found on the Anxiety and Psychomotor factors, and a medium effect size on the Depression factor.

Table 7.7 shows the Tukey post-hoc tests that were significant or indicated a trend for differences between the pain groups on the HADS factors (for the full table of post-hoc tests for each of the HADS factors see 'Output – Study 3' in Appendix D on the CD). The medium pain group showed significantly higher mean anxiety ($p < .001$), depression ($p < .01$), and psychomotor ($p < .001$) scores than the low pain group. The high pain group displayed significantly higher mean psychomotor scores than the low pain group ($p < .01$), and there was a trend for the high pain group to report higher mean anxiety ($p = .056$) and depression ($p = .066$) scores.

The Time x Pain interaction was non-significant for the Anxiety factor, $F(8, 341) = 1.48$, $p = .168$, $\eta^2_{partial} = .03$; Depression factor, $F(7, 309) = 1.63$, $p = .126$, $\eta^2_{partial} = .04$; and the Psychomotor factor, $F(8, 373) = 1.56$, $p = .132$, $\eta^2_{partial} = .04$.

Table 7.6

Tests of Within-Subjects & Between-Subjects Effects for Pain on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	341	2.26	.066	.03	.64
Pain	2	89	10.73***	< .001	.19	.99
Time x Pain[a]	8	341	1.48	.168	.03	.65
Depression						
Time since TBI[a]	3	309	2.38	.060	.03	.64
Pain	2	89	6.04*	.003	.12	.87
Time x Pain[a]	7	309	1.63	.126	.04	.67
Psychomotor						
Time since TBI[a]	4	373	5.52***	< .001	.06	.98
Pain	2	89	12.64***	< .001	.22	1.00
Time x Pain[a]	8	373	1.56	.132	.04	.71

Note. [a]Greenhouse-Geisser results are reported
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 7.7

Significant/Trend Tukey Post-hoc Tests for Pain on the HADS Factors

HADS Factor/Comparison	Mean Difference	*SE*	*p*	95% CI LL	95% CI UL
Anxiety					
Low Pain & Medium Pain	-1.43	.32	< .001	-2.20	-.66
Low Pain & High Pain	-1.51	.65	.056	-3.05	.03
Depression					
Low Pain & Medium Pain	-.73	.24	.008	-1.30	-.16
Low Pain & High Pain	-1.08	.47	.066	-2.21	.06
Psychomotor					
Low Pain & Medium Pain	-1.42	.33	< .001	-2.20	-.63
Low Pain & High Pain	-2.28	.66	.002	-3.85	-.72

7.3.4 Fatigue

Cross-sectional sample. One-way between-subjects ANOVAs were conducted at each follow-up assessment, to compare participants' HADS scores based on their level of fatigue (Table 7.8). Three groups were included in the analyses, based upon McCaffery and Beebe (1993; low fatigue [VAS-F = 0–3]; medium fatigue [VAS-F = 4–6]; and high fatigue [VAS-F = 7–10]). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 344 to 577 participants: low fatigue (n = 135–252), medium fatigue (n = 177–269), and high fatigue (n = 37–74; see Figure 7.1). Table D5 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores are plotted for the HADS Anxiety factor (Figure 7.8), Depression factor (Figure D1 – Appendix D), and Psychomotor factor (Figure D2 – Appendix D).

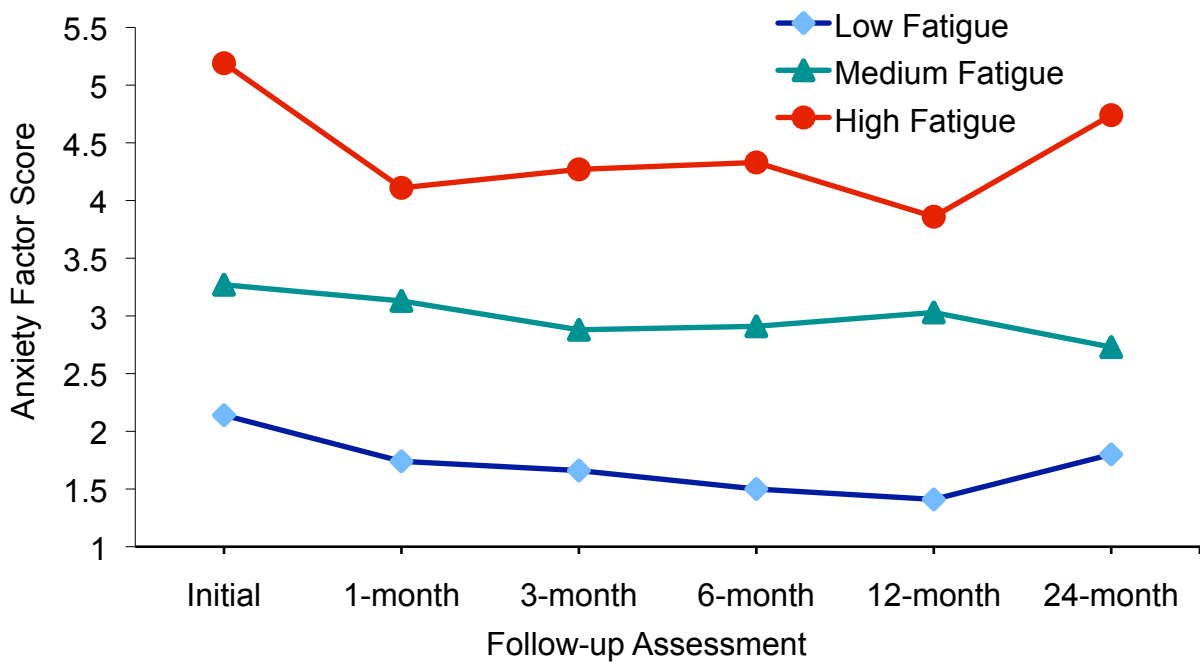

Figure 7.8. Mean anxiety factor scores over time for fatigue (cross-sectional sample).

Anxiety factor. Significant differences in mean anxiety scores (Figure 7.8; Table 7.8) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated large effect sizes at each follow-up. Significant Tukey post-hoc tests for each of the HADS factors are

displayed in Table 7.9 (for the full table of post-hoc comparisons see 'Output – Study 3' in Appendix D on the CD). The high fatigue group showed significantly higher mean anxiety scores than the low fatigue group at each follow-up ($p < .001$). The high fatigue group reported significantly higher mean anxiety scores than the medium fatigue group at each follow-up ($p < .05$ at 12 months; $p < .001$ at all other follow-ups). The medium fatigue group showed significantly higher mean anxiety scores ($p < .001$) than the low fatigue group at each follow-up.

Depression factor. Consistent with the findings for the Anxiety factor, highly significant differences in mean depression scores (Figure D1 – Appendix D; Table 7.8) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated large effect sizes at each follow-up. Tukey post-hoc tests (Table 7.9) showed the high fatigue group reported significantly higher mean depression scores than the low fatigue group at each follow-up ($p < .001$). The high fatigue group reported significantly higher mean depression scores ($p < .001$) than the medium fatigue group at each follow-up ($p < .05$ at 1 month; $p < .001$ at all other follow-ups). The medium fatigue group showed significantly higher mean depression scores than the low fatigue group at each follow-up ($p < .001$).

Psychomotor factor. Consistent with the findings for the Anxiety and Depression factors, highly significant differences in mean psychomotor scores (Figure D2 – Appendix D; Table 7.8) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated large effect sizes at each follow-up. Tukey post-hoc tests (Table 7.9) showed the high fatigue group reported significantly higher mean psychomotor scores than the low fatigue group at each follow-up ($p < .001$). The high fatigue group displayed significantly higher mean psychomotor scores than the medium fatigue group at each follow-up ($p < .05$ at 1 month and 12 months; $p < .01$ at 6 months; $p < .001$ at the initial, 3-month, and 24-month follow-ups).

The medium fatigue group showed significantly higher mean psychomotor scores than the low fatigue group at each follow-up ($p < .001$).

Table 7.8

ANOVA for Fatigue on the HADS Factors – Cross-Sectional Sample

Follow-up/ HADS Factor	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
Initial (<15 days)						
Anxiety	2	207	34.99***	.14	< .001	1.00
Depression	2	185	34.87***	.14	< .001	1.00
Psychomotor	2	201	33.37***	.14	< .001	1.00
1-month						
Anxiety	2	104	21.44***	.13	< .001	1.00
Depression	2	93	21.03***	.13	< .001	1.00
Psychomotor	2	101	23.03***	.14	< .001	1.00
3-month						
Anxiety	2	188	33.45***	.13	< .001	1.00
Depression	2	181	31.64***	.13	< .001	1.00
Psychomotor	2	202	54.92***	.19	< .001	1.00
6-month						
Anxiety	2	133	36.09***	.14	< .001	1.00
Depression	2	120	31.01***	.13	< .001	1.00
Psychomotor	2	123	40.34***	.17	< .001	1.00
12-month						
Anxiety	2	166	36.79***	.14	< .001	1.00
Depression	2	132	26.63***	.12	< .001	1.00
Psychomotor	2	175	37.43***	.14	< .001	1.00
24-month						
Anxiety	2	110	26.04***	.13	< .001	1.00
Depression	2	95	28.35***	.15	< .001	1.00
Psychomotor	2	96	25.40***	.14	< .001	1.00

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.9

Significant Tukey Post-hoc Tests for Fatigue on the HADS Factors – Cross-Sectional Sample

Follow-up	Initial Pain Comparison	*Anxiety*		*Depression*		*Psychomotor*	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial	Low & Medium	.25	< .001	.17	< .001	.22	< .001
Initial	Low & High	.35	< .001	.24	< .001	.31	< .001
Initial	Medium & High	.32	< .001	.22	< .001	.29	< .001
1-month	Low & Medium	.25	< .001	.19	< .001	.25	< .001
1-month	Low & High	.40	< .001	.30	< .001	.41	< .001
1-month	Medium & High	.39	< .001	.29	.012	.40	.032
3-month	Low & Medium	.21	< .001	.14	< .001	.18	< .001
3-month	Low & High	.30	< .001	.21	< .001	.27	< .001
3-month	Medium & High	.30	< .001	.21	< .001	.26	< .001
6-month	Low & Medium	.20	< .001	.14	< .001	.19	< .001
6-month	Low & High	.33	< .001	.23	< .001	.31	< .001
6-month	Medium & High	.33	< .001	.23	< .001	.31	.002
12-month	Low & Medium	.21	< .001	.16	< .001	.20	< .001
12-month	Low & High	.35	< .001	.26	< .001	.33	< .001
12-month	Medium & High	.35	.046	.25	< .001	.33	.047
24-month	Low & Medium	.22	< .001	.16	< .001	.21	< .001
24-month	Low & High	.36	< .001	.26	< .001	.34	< .001
24-month	Medium & High	.36	< .001	.26	< .001	.34	< .001

7.3.5 Initial Fatigue

Cross-sectional sample. One-way between-subjects ANOVAs were conducted at each follow-up assessment to compare participants' HADS scores based upon their level of fatigue measured at the initial follow-up (Table 7.10). Three initial fatigue groups were included in the analyses: These groups were categorized as: low fatigue (VAS-F = 0–3), medium fatigue (VAS-F = 4–6), and high fatigue (VAS-F = 7–10; McCaffery & Beebe, 1993). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 334 to 520 participants: low fatigue (n = 108–176), medium fatigue (n = 180–285), and high fatigue (n = 48–69; see Figure 7.1). Table D6 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figures 7.9, 7.10, and 7.11.

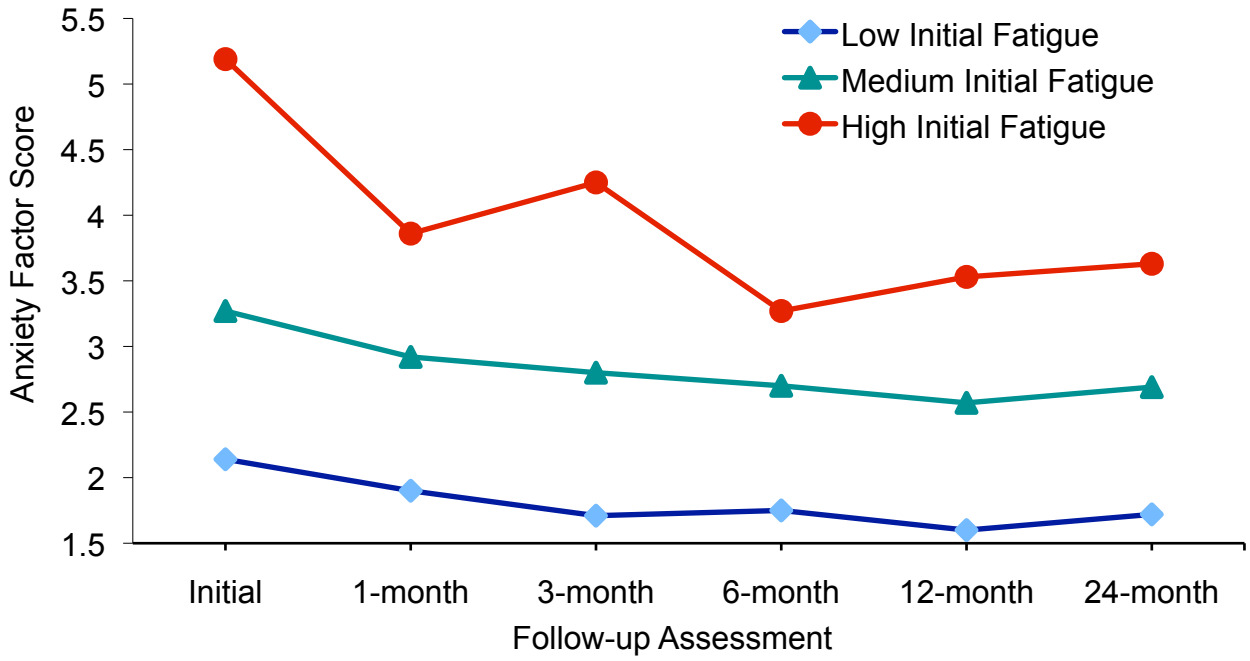

Figure 7.9. Mean anxiety factor scores over time for initial fatigue (cross-sectional sample).

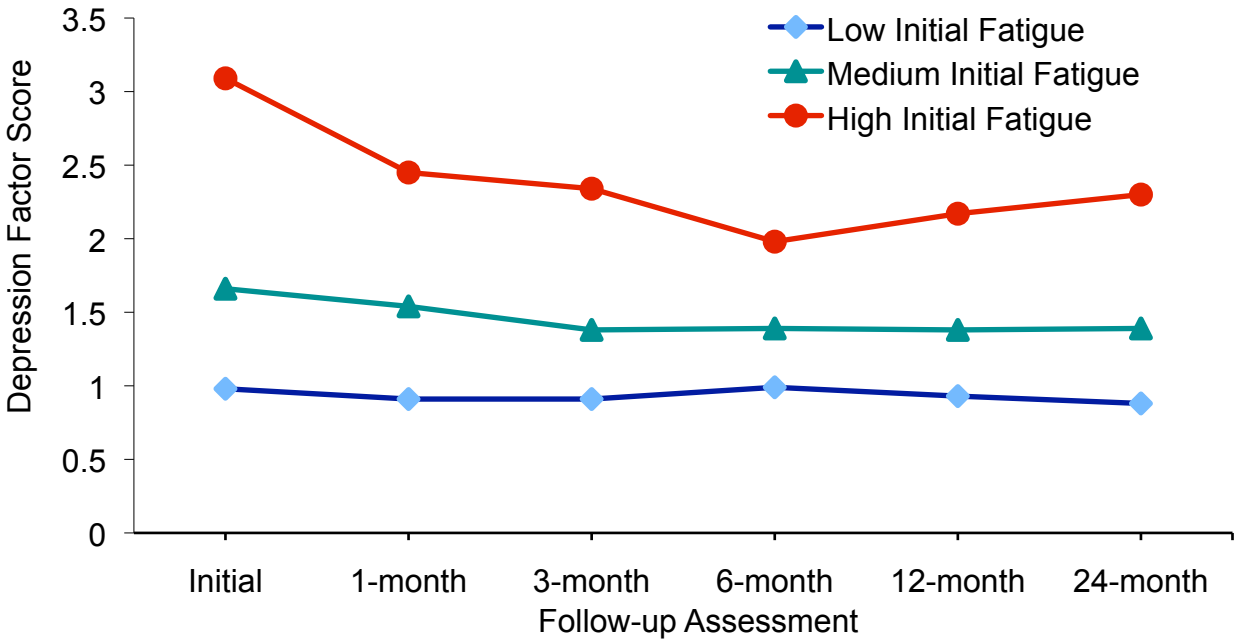

Figure 7.10. Mean depression factor scores over time for initial fatigue (cross-sectional sample).

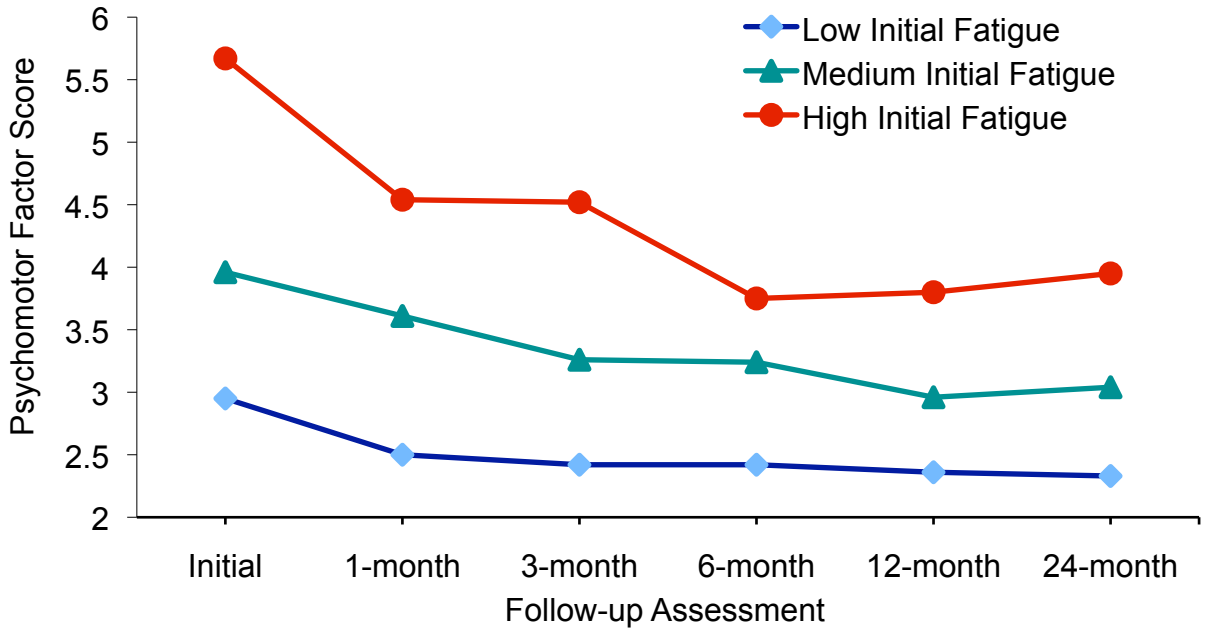

Figure 7.11. Mean psychomotor factor scores over time for initial fatigue (cross-sectional sample).

Anxiety factor. Highly significant differences in mean anxiety scores (Figure 7.9; Table 7.10) were found between the groups at each follow-up ($p < .001$). η^2_{partial} indicated a medium effect size at the initial follow-up and small effect sizes at all other follow-ups. Significant Tukey post-hoc tests for the HADS factors are displayed in Table 7.11 (for the

full table of post-hoc comparisons see 'Output – Study 3' in Appendix D on the CD). The high fatigue group showed significantly higher mean anxiety scores than the low fatigue group at each follow-up ($p < .001$). The medium fatigue group showed significantly higher mean anxiety scores than the low fatigue group at each follow-up ($p < .001$). The high fatigue group showed significantly higher mean anxiety scores than the medium fatigue group at the initial ($p < .001$), 1-month ($p < .05$), 3-month ($p < .001$), 12-month ($p < .05$), and 24-month ($p < .05$) follow-ups (Figure 7.9).

Depression factor. Highly significant differences in mean depression scores (Figure 7.10; Table 7.10) were found between the groups at each follow-up ($p < .001$). η^2_{partial} showed a medium effect size at the initial follow-up and small effect sizes at all other follow-ups. Tukey post-hoc tests (Table 7.11) showed the high fatigue group reported significantly higher mean depression scores than the low fatigue group at each follow-up ($p < .001$). The high fatigue group displayed significantly higher mean depression scores than the medium fatigue group at each follow-up ($p < .05$ at 6 months; $p < .01$ at 1 month, 12 month, and 24 months; $p < .001$ at the initial and 3-month follow-ups). The medium fatigue group showed significantly higher mean depression scores than the low fatigue group at each follow-up ($p < .05$ at 6, 12, and 24 months; $p < .01$ at 1 and 3 months; $p < .001$ at the initial follow-up; Figure 7.10).

Psychomotor factor. Highly significant differences in mean psychomotor scores (Figure 7.11; Table 7.10) were found between the groups at each follow-up ($p < .001$). A medium effect size was noted at the initial, 1-month, and 3-month follow-ups and small effect sizes at the other follow-ups. Tukey post-hoc tests (Table 7.11) showed the high fatigue group reported significantly higher mean psychomotor scores than the low fatigue group at each follow-up ($p < .001$). The high fatigue group reported significantly higher mean psychomotor scores than the medium fatigue group at the initial, 1-month ($p < .05$), 3-month

($p < .001$), 12-month ($p < .05$), and 24-month ($p < .05$) follow-ups. The medium fatigue group showed significantly higher mean psychomotor scores than the low fatigue group at each follow-up ($p < .05$ at 12 months; $p < .01$ at 24 months; $p < .001$ at the initial, 1-month, 3-month, and 6-month follow-ups; Figure 7.11).

Table 7.10

ANOVA for Initial Fatigue on the HADS Factors – Cross-Sectional Sample

Follow-up/ HADS Factor	*df* between	*df* within	*F*	$\eta^2_{partial}$	*p*	Power
Initial (<15 days)						
Anxiety	2	207	34.99***	.14	< .001	1.00
Depression	2	171	34.87***	.14	< .001	1.00
Psychomotor	2	201	33.37***	.14	< .001	1.00
1-month						
Anxiety	2	136	12.78***	.08	< .001	1.00
Depression	2	122	12.55***	.08	< .001	1.00
Psychomotor	2	331	14.40***	.08	< .001	1.00
3-month						
Anxiety	2	161	25.29***	.10	< .001	1.00
Depression	2	163	15.10***	.06	< .001	1.00
Psychomotor	2	512	22.99***	.08	< .001	1.00
6-month						
Anxiety	2	171	11.80***	.05	< .001	1.00
Depression	2	198	7.62***	.04	.001	.99
Psychomotor	2	517	10.72***	.04	< .001	.99
12-month						
Anxiety	2	178	14.90***	.07	< .001	1.00
Depression	2	160	9.55***	.05	< .001	.99
Psychomotor	2	194	8.76***	.04	< .001	.98
24-month						
Anxiety	2	159	14.43***	.06	< .001	1.00
Depression	2	119	10.35***	.05	< .001	.99
Psychomotor	2	143	9.40***	.05	< .001	.99

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.11

Significant Tukey Post-hoc Tests for Initial Fatigue on the HADS Factors – Cross-Sectional Sample

		Anxiety		*Depression*		*Psychomotor*	
Follow-up	Initial Pain Comparison	*SE*	*p*	*SE*	*p*	*SE*	*p*
Initial	Low & Medium	.25	< .001	.17	< .001	.22	< .001
Initial	Low & High	.35	< .001	.24	< .001	.31	< .001
Initial	Medium & High	.32	< .001	.22	< .001	.29	< .001
1-month	Low & Medium	.27	.001	.21	.006	.28	< .001
1-month	Low & High	.39	< .001	.30	< .001	.41	< .001
1-month	Medium & High	.37	.030	.28	.004	.38	.041
3-month	Low & Medium	.27	< .001	.16	.009	.21	< .001
3-month	Low & High	.35	< .001	.24	< .001	.32	< .001
3-month	Medium & High	.33	< .001	.23	< .001	.30	< .001
6-month	Low & Medium	.23	< .001	.16	.035	.22	< .001
6-month	Low & High	.35	< .001	.25	< .001	.34	< .001
6-month	Medium & High	–	–	.24	.037	–	–
12-month	Low & Medium	.24	< .001	.18	.035	.23	.025
12-month	Low & High	.37	< .001	.27	< .001	.34	< .001
12-month	Medium & High	.35	.014	.25	.005	.33	.027
24-month	Low & Medium	.25	< .001	.19	.019	.24	.010
24-month	Low & High	.38	< .001	.29	< .001	.37	< .001
24-month	Medium & High	.36	.023	.27	.003	.35	.024

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' fatigue level on HADS scores across six time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 98 participants who completed the VAS-F at the initial follow-up and the HADS at every follow-up assessment. Three groups were included in the analyses, low fatigue (n = 36), medium fatigue (n = 50), and high fatigue (n = 12). These groups were categorized as: low fatigue (VASF = 0–3); medium fatigue (VASF = 4–6); and high fatigue (VASF =7–10; McCaffery & Beebe, 1993). Mean HADS factor scores and standard deviations are shown in Table D7 (Appendix D). The mean scores for each HADS factor are plotted over time in Figures 7.12, 7.13, and 7.14.

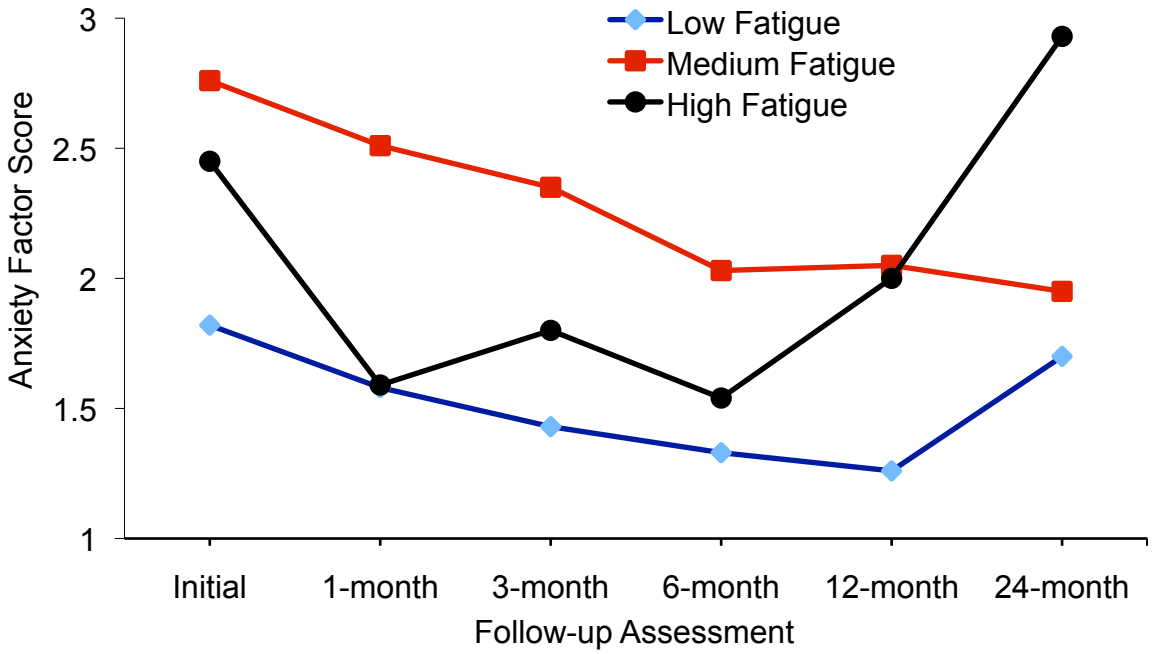

Figure 7.12. Mean anxiety factor scores over time for fatigue (longitudinal sample).

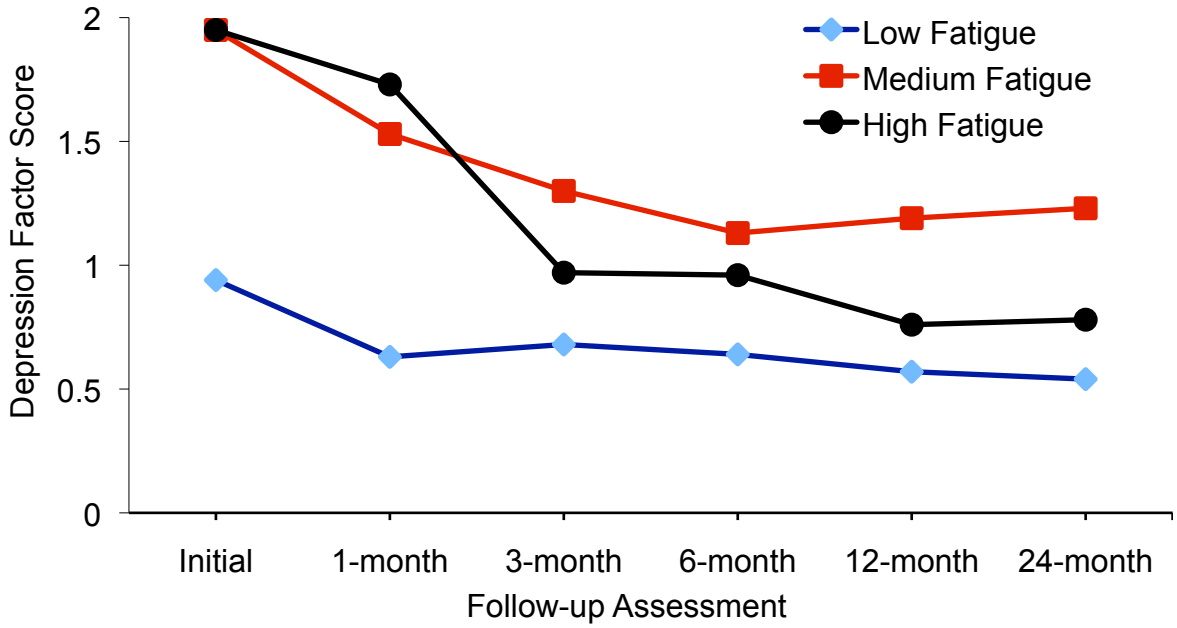

Figure 7.13. Mean depression factor scores over time for fatigue (longitudinal sample).

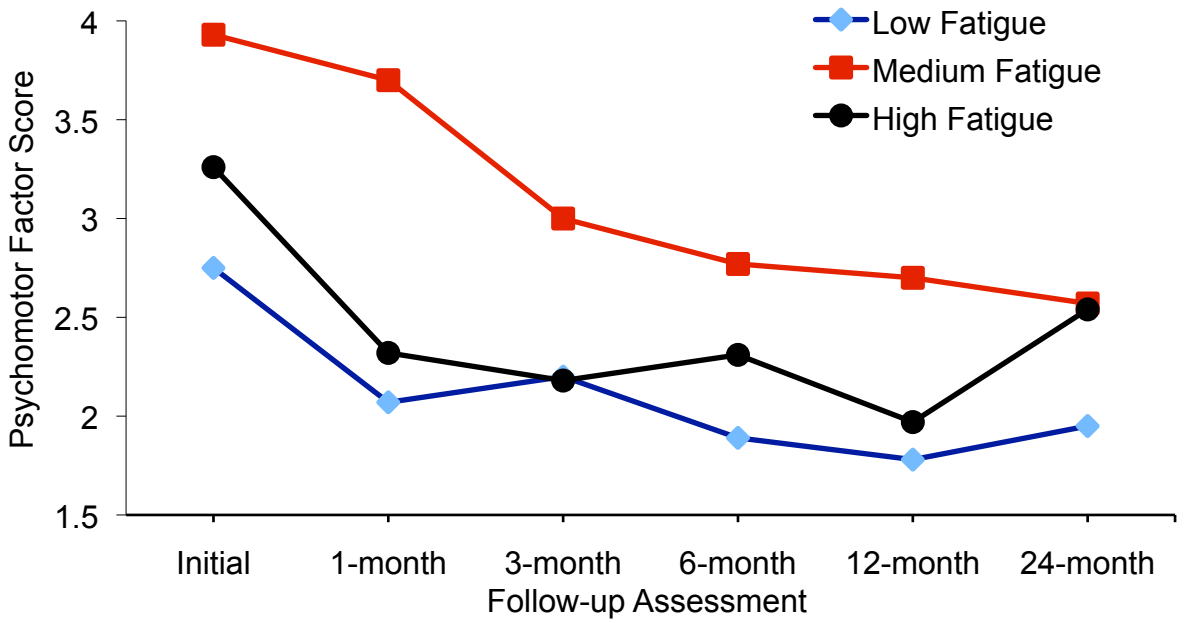

Figure 7.14. Mean psychomotor factor scores over time for fatigue (longitudinal sample).

Table 7.12 shows the tests of within-subjects effects for fatigue on the HADS factors. There was a main effect for time on the Anxiety factor, $F(4, 375) = 3.85$, $p = .005$, $\eta^2_{\text{partial}} = .04$; Depression factor, $F(4, 335) = 5.70$, $p < .001$, $\eta^2_{\text{partial}} = .06$; and Psychomotor factor, $F(4,$

404) = 7.13, $p < .001$, $\eta^2_{partial} = .07$. These results indicate a significant reduction in participants' mean HADS scores over time. For the main effect of time since TBI, a small effect size was found on the Anxiety factor, and medium effect sizes for the Depression and Psychomotor factors.

Bonferroni post-hoc comparisons for time since TBI, for each of the HADS factors are displayed in 'Output – Study 3' (Appendix D on the CD). Table D8 (Appendix D) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. A significant difference in mean anxiety scores was found between the initial and 6-month follow-up ($p = .006$); and there was a trend for a difference in mean anxiety scores between the 6-month and 24-month follow-up ($p = .053$; see Figure 7.12). Significant differences in mean depression scores were found between the initial follow-up and: the 3-month ($p = .034$), 6-month ($p = .018$), 12-month ($p = .027$), and 24-month ($p = .042$) follow-ups (Figure 7.13). There was a significant difference in mean depression scores between the 1-month and 12-month ($p = .042$) follow-ups. Significant differences in mean psychomotor scores were found between the initial follow-up and: the 3-month ($p = .012$), 6-month ($p = .001$), and 12-month ($p < .001$) follow-ups (Figure 7.14). There was a trend for a difference in mean psychomotor scores between the initial and 24-month follow-up ($p = .010$), and the 1-month and 12-month follow-up ($p = .068$).

Tests of between-subjects effects for fatigue on the HADS factors are displayed in Table 7.12. The main effect comparing the three fatigue groups was non significant for the Anxiety factor, $F(2, 95) = 2.21$, $p = .116$, $\eta^2_{partial} = .04$; significant for the Depression factor, $F(2, 95) = 4.60$, $p = .012$, $\eta^2_{partial} = .09$; and significant for the Psychomotor factor, $F(2, 95) = 4.12$, $p = .019$, $\eta^2_{partial} = .02$. For the main effect of fatigue, small effect sizes were found on the Anxiety and Psychomotor factor, and a medium effect size on the Depression factor.

Significant Tukey post-hoc tests are displayed in Table 7.13 (for the full table of post-hoc tests for each of the HADS factors see 'Output – Study 3' in Appendix D on the CD). These indicated the medium fatigue group showed significantly higher mean depression ($p < .01$) and psychomotor ($p < .05$) scores than the low fatigue group.

There was a trend for a Time x Fatigue interaction for the Anxiety factor, $F(8, 375) = 1.86$, $p = .067$, $\eta^2_{partial} = .04$. No significant Time x Fatigue interactions were found for the Depression factor $F(7, 335) = .81$, $p = .584$, $\eta^2_{partial} = .02$; and Psychomotor factor $F(9, 404) = 1.12$, $p = .345$, $\eta^2_{partial} = .02$.

Table 7.12

Tests of Within-Subjects & Between-Subjects Effects for Fatigue on the HADS Factors

HADS Factor/Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	375	3.85**	.005	.04	.89
Fatigue	2	95	2.21	.116	.04	.64
Time x Fatigue[a]	8	375	1.86	.067	.04	.78
Depression						
Time since TBI[a]	4	335	5.70***	< .001	.06	.97
Fatigue	2	95	4.60*	.012	.09	.77
Time x Fatigue[a]	7	335	.81	.584	.02	.35
Psychomotor						
Time since TBI[a]	4	404	7.13***	< .001	.07	.98
Fatigue	2	95	4.12*	.019	.08	.72
Time x Fatigue[a]	9	404	1.12	.345	.02	.54

Note. [a]Greenhouse-Geisser results are reported
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 7.13

Significant Tukey Post-hoc Tests for Fatigue on the HADS Factors

HADS Factor/Comparison	Mean Difference	*SE*	*p*	95% CI	
				LL	UL
Depression					
Low & Medium	-.72	.24	.009	-1.29	-.15
Psychomotor					
Low & Medium	-1.01	.36	.016	-1.85	-.16

7.3.6 Initial Pain & Initial Fatigue

To explore the relationship between pain, fatigue, and mood; two-way between-subjects ANOVAs were conducted at each follow-up assessment. In these analyses, the medium and high pain groups from previous pain analyses were collapsed into a single group labelled high pain. The medium and high fatigue groups from previous fatigue analyses were collapsed into a single group labelled high fatigue.

There were four groups in the analyses: low pain, high pain, low fatigue, and high fatigue. Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis and ranged from 304 to 489 participants: low pain (n = 158–275), high pain (n = 146–217), low fatigue (n = 98–164), and high fatigue (n = 206–325; see 'Output – Study 3' in Appendix D on the CD). Table D9 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figures 7.15, 7.16, and 7.17.

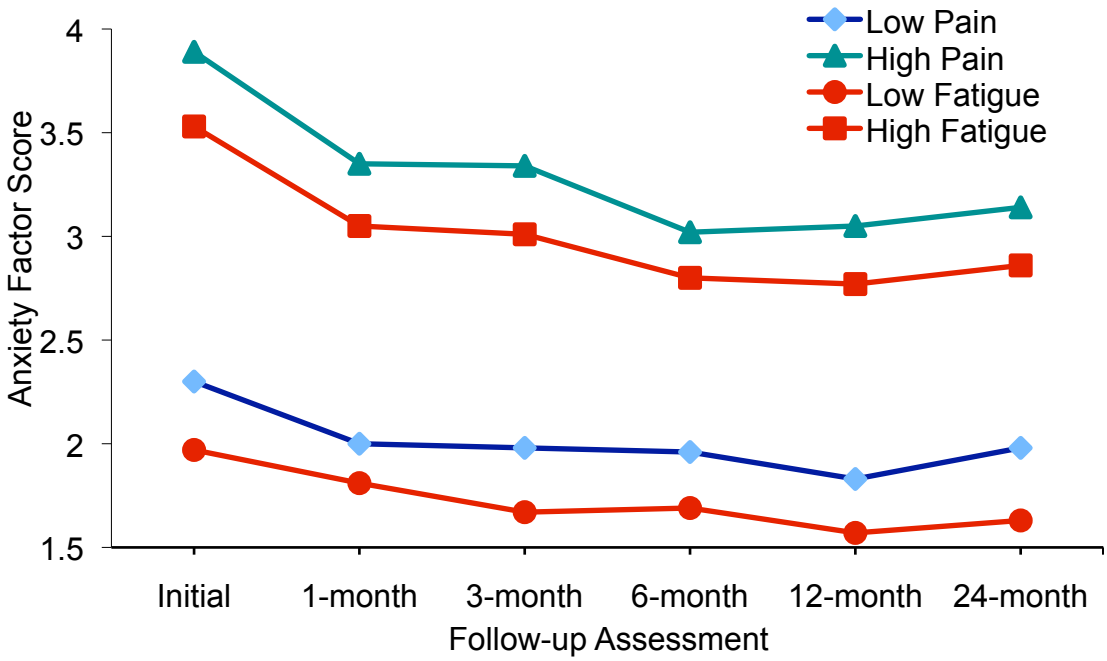

Figure 7.15. Mean anxiety factor scores over time for initial pain & fatigue.

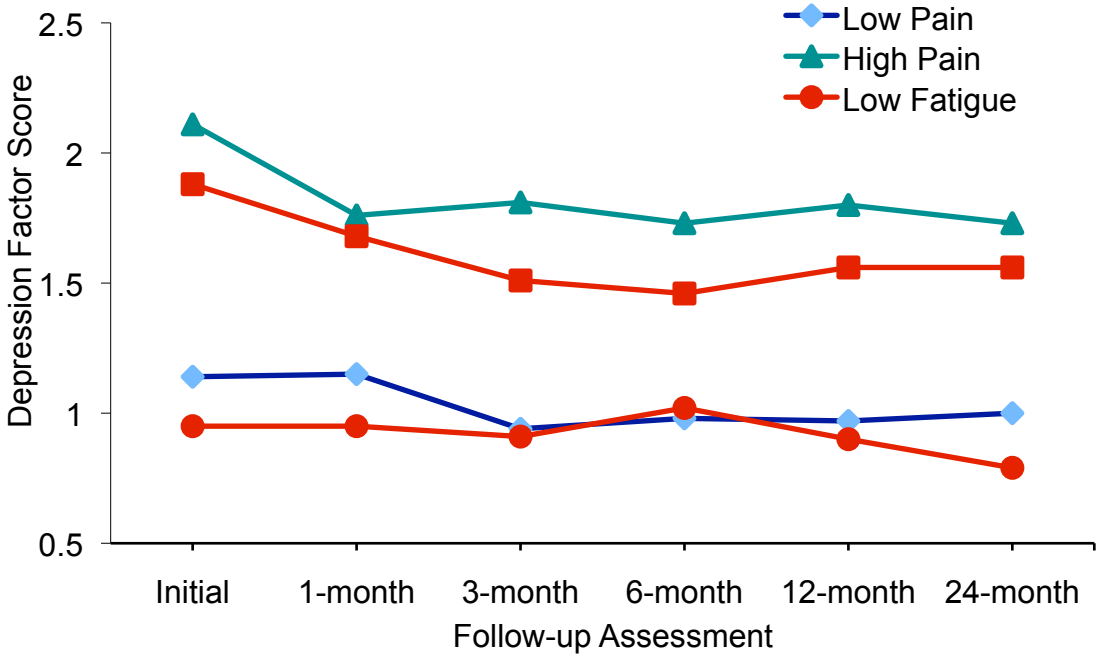

Figure 7.16. Mean depression factor scores over time for initial pain & fatigue.

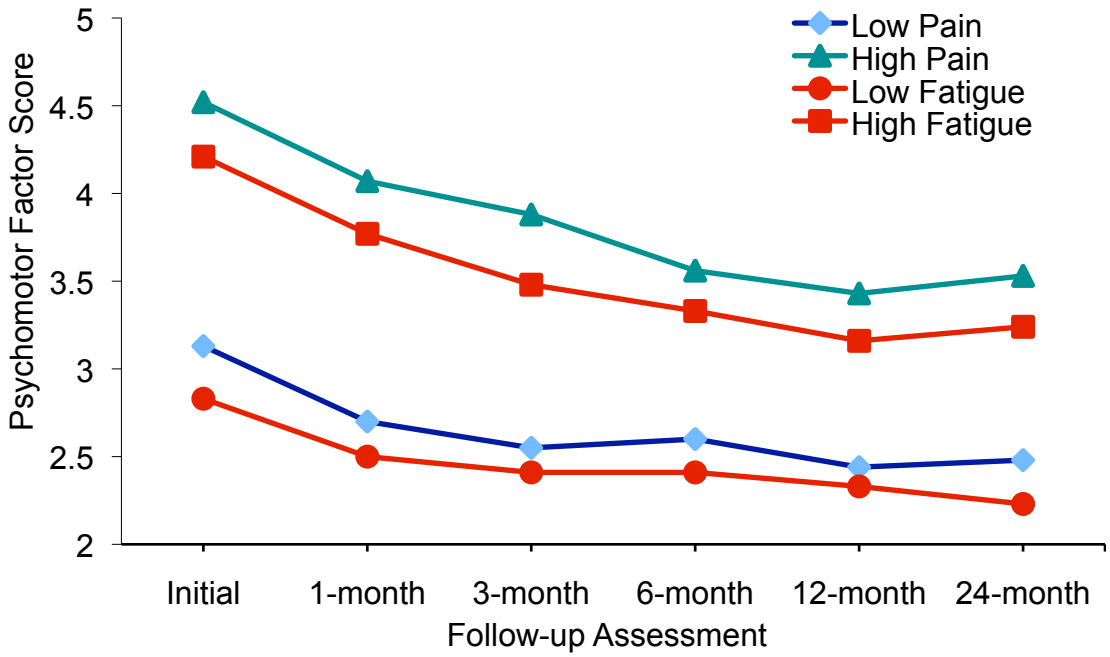

Figure 7.17. Mean psychomotor factor scores over time for initial pain & fatigue.

Anxiety factor. On the Anxiety factor (Figure 7.15; Table 7.14), a significant main effect was found for initial pain at each follow-up ($p < .01$ at 1 month, 3 months, and 12 months; $p < .001$ at the initial, 6-month, and 24-month follow-ups). A significant main effect was found for initial fatigue at each follow-up ($p < .001$). The Initial Pain x Initial Fatigue interaction was significant at 3 months ($p < .01$) and 12 months ($p < .05$); and when a more conservative alpha level was adopted ($p < .01$), there was a strong trend for an Initial Pain x Initial Fatigue interaction at the 1-month follow-up ($p = .043$).

η^2_{partial} indicated small effect sizes for the main effect of initial pain at each follow-up. A moderate effect size was found for the main effect of initial fatigue at 3 months, with small effect sizes at all other follow-ups. Small effect sizes were found for the Initial Pain x Initial Fatigue interaction at each follow-up.

Depression factor. On the Depression factor (Figure 7.16; Table 7.15), a significant main effect was found for initial pain at the initial ($p < .01$), 3-month ($p < .01$), 6-month ($p < .001$), 12-month ($p < .01$), and 24-month ($p < .01$) follow-ups. A significant main effect was

found for initial fatigue at the initial ($p < .001$), 1-month ($p < .01$), 3-month ($p < .001$), 12-month ($p < .01$), and 24-month ($p < .001$) follow-ups, with a strong trend for a main effect for initial fatigue at 6 months ($p = .043$) when a more conservative alpha level was adopted ($p < .01$).

There was a significant Initial Pain x Initial Fatigue interaction at 3 months ($p < .01$), and a trend for an Initial Pain x Initial Fatigue interaction at 12 months ($p = .020$). η^2_{partial} showed small effect sizes for the main effects and interactions at each follow-up.

Psychomotor factor. On the Psychomotor factor (Figure 7.17; Table 7.16), a significant main effect was found for initial pain at the initial ($p < .001$), 1-month ($p < .001$), 3-month ($p < .001$), 6-month ($p < .01$), and 24-month ($p < .001$) follow-ups; with a strong trend for a main effect for initial pain at 12 months ($p = .028$) when a more conservative alpha level was adopted ($p < .01$).

A significant main effect was found for initial fatigue at each follow-up assessment ($p < .01$ at 24 months; $p < .001$ at all other follow-ups). The Initial Pain x Initial Fatigue interaction was significant at 12 months ($p < .01$) and there was a trend for an Initial Pain x Initial Fatigue interaction at 3 months ($p = .021$) when a more conservative alpha level was adopted ($p < .01$). η^2_{partial} indicated small effect sizes for the main effects and interactions at each follow-up.

Table 7.14

Two-way Between-subjects ANOVA for Initial Pain and Fatigue on the Anxiety Factor

Follow-up/HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Initial Pain	1	398	19.95***	< .001	.05	.99
Initial Fatigue	1	398	13.05***	< .001	.04	.98
Initial Pain x Initial Fatigue	1	398	.35	.921	.00	.05
1-month						
Initial Pain	1	300	9.75**	.002	.03	.88
Initial Fatigue	1	300	14.35***	< .001	.05	.97
Initial Pain x Initial Fatigue	1	300	4.13*	.043	.01	.53
3-month						
Initial Pain	1	478	10.06	.002	.02	.89
Initial Fatigue	1	478	28.17	< .001	.06	1.00
Initial Pain x Initial Fatigue	1	478	8.14	.005	.02	.81
6-month						
Initial Pain	1	485	11.36***	.001	.02	.92
Initial Fatigue	1	485	18.11***	< .001	.04	.99
Initial Pain x Initial Fatigue	1	485	1.24	.267	.00	.20
12-month						
Initial Pain	1	422	8.47**	.004	.02	.83
Initial Fatigue	1	422	18.11***	< .001	.04	.99
Initial Pain x Initial Fatigue	1	422	4.83*	.028	.01	.59
24-month						
Initial Pain	1	391	16.13***	< .001	.04	.98
Initial Fatigue	1	391	12.23***	.001	.03	.94
Initial Pain x Initial Fatigue	1	391	.92	.338	.00	.16

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.15

Two-way Between-subjects ANOVA for Initial Pain and Fatigue on the Depression Factor

Follow-up/HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Initial Pain	1	398	10.01**	.002	.03	.88
Initial Fatigue	1	398	13.88***	< .001	.03	.96
Initial Pain x Initial Fatigue	1	398	1.56	.213	.00	.24
1-month						
Initial Pain	1	300	1.90	.169	.01	.28
Initial Fatigue	1	300	.94**	.002	.03	.87
Initial Pain x Initial Fatigue	1	300	2.68	.103	.01	.37
3-month						
Initial Pain	1	478	9.88**	.002	.02	.88
Initial Fatigue	1	478	10.79***	.001	.02	.91
Initial Pain x Initial Fatigue	1	478	8.25**	.004	.02	.82
6-month						
Initial Pain	1	485	14.71***	< .001	.03	.97
Initial Fatigue	1	485	4.14*	.043	.01	.53
Initial Pain x Initial Fatigue	1	485	.78	.377	.00	.14
12-month						
Initial Pain	1	422	7.85**	.005	.02	.80
Initial Fatigue	1	422	9.90**	.002	.02	.88
Initial Pain x Initial Fatigue	1	422	5.41*	.020	.01	.64
24-month						
Initial Pain	1	391	6.86**	.009	.02	.74
Initial Fatigue	1	391	11.17***	.001	.03	.92
Initial Pain x Initial Fatigue	1	391	.53	.466	.00	.11

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.16

Two-way Between-subjects ANOVA for Initial Pain and Fatigue on the Psychomotor Factor

Follow-up/HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Initial Pain	1	398	19.95***	< .001	.05	.99
Initial Fatigue	1	398	13.05***	< .001	.03	.95
Initial Pain x Initial Fatigue	1	398	.35	.552	.00	.09
1-month						
Initial Pain	1	300	11.74***	.001	.04	.93
Initial Fatigue	1	300	11.25***	.001	.04	.92
Initial Pain x Initial Fatigue	1	300	.71	.402	.00	.13
3-month						
Initial Pain	1	478	15.72***	< .001	.03	.98
Initial Fatigue	1	478	17.42***	< .001	.04	.99
Initial Pain x Initial Fatigue	1	478	5.40*	.021	.01	.64
6-month						
Initial Pain	1	485	9.84**	.002	.02	.88
Initial Fatigue	1	485	13.05***	< .001	.03	.95
Initial Pain x Initial Fatigue	1	485	1.51	.220	.00	.23
12-month						
Initial Pain	1	422	4.88*	.028	.01	.60
Initial Fatigue	1	422	11.08***	.001	.03	.91
Initial Pain x Initial Fatigue	1	422	8.18**	.004	.02	.81
24-month						
Initial Pain	1	391	13.24***	< .001	.03	.95
Initial Fatigue	1	391	8.98**	.003	.02	.85
Initial Pain x Initial Fatigue	1	391	.22	.643	.00	.08

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Interaction. Table 7.17 displays means and standard deviations for the interactions between initial pain and initial fatigue on the HADS factors. Interaction plots for the Anxiety factor (Figures 7.18, 7.19, and 7.20), Depression factor (Figures D3 and D4 in Appendix D), and Psychomotor factor (Figures D5 and D6 in Appendix D) are also shown. There were four comparisons: 'low pain & low fatigue'; 'low pain & high fatigue'; 'high pain & low fatigue'; and 'high pain & high fatigue'.

The results showed participants with 'high pain & high fatigue' reported higher mean anxiety scores at 1 month, 3 months, and 12 months, when compared with the other comparisons. Participants with 'high pain & high fatigue' displayed higher mean depression and psychomotor scores at 3 months and 12 months, when compared with the other comparisons. Those in the low fatigue group consistently experienced the lowest mean HADS scores, regardless of whether they also experienced low or high pain.

Table 7.17

Descriptive Statistics for Initial Pain & Fatigue Interactions on the HADS (Two-way Between-Subjects ANOVAs)

HADS Factor/Group		Anxiety			Depression		Psychomotor	
		1 month	3 month	12 month	3 month	12 month	3 month	12 month
Low Pain &	*M*	1.73	1.65	1.52	.97	.88	2.28	2.38
Low Fatigue	*SD*	(1.68)	(1.77)	(1.92)	(1.27)	(1.44)	(1.86)	(2.03)
Low Pain &	*M*	2.22	2.25	2.06	1.29	1.04	3.03	2.49
High Fatigue	*SD*	(1.82)	(2.06)	(2.27)	(1.66)	(1.55)	(2.03)	(1.99)
High Pain &	*M*	2.03	1.73	1.71	.91	.97	3.06	2.21
Low Fatigue	*SD*	(2.20)	(2.00)	(2.25)	(1.50)	(1.60)	(2.52)	(2.47)
High Pain &	*M*	3.67	3.71	3.40	1.97	2.02	4.31	3.74
High Fatigue	*SD*	(2.51)	(2.74)	(2.68)	(1.97)	(2.02)	(2.59)	(2.44)

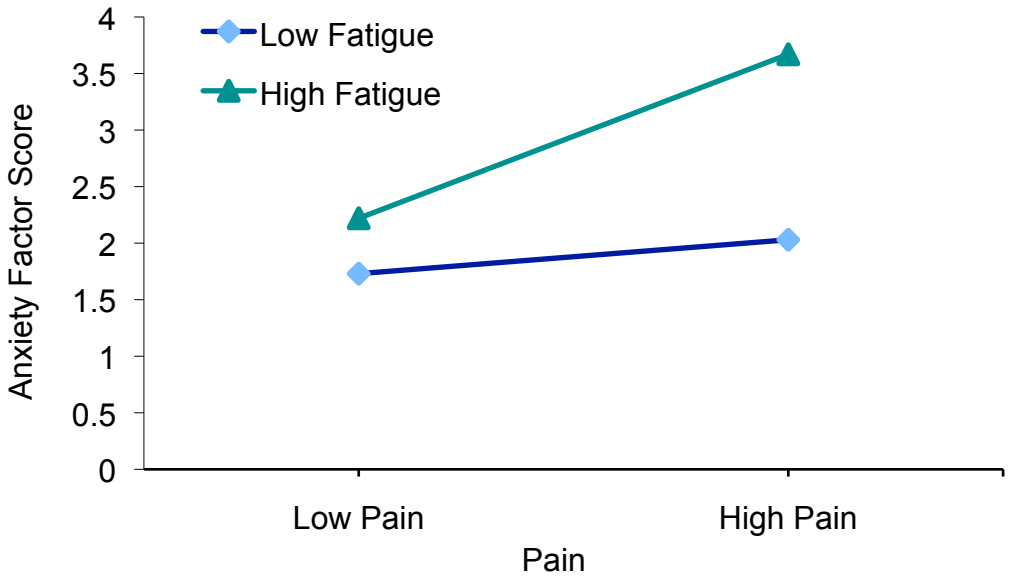

Figure 7.18. Interaction for initial pain & fatigue on the anxiety factor at 1 month.

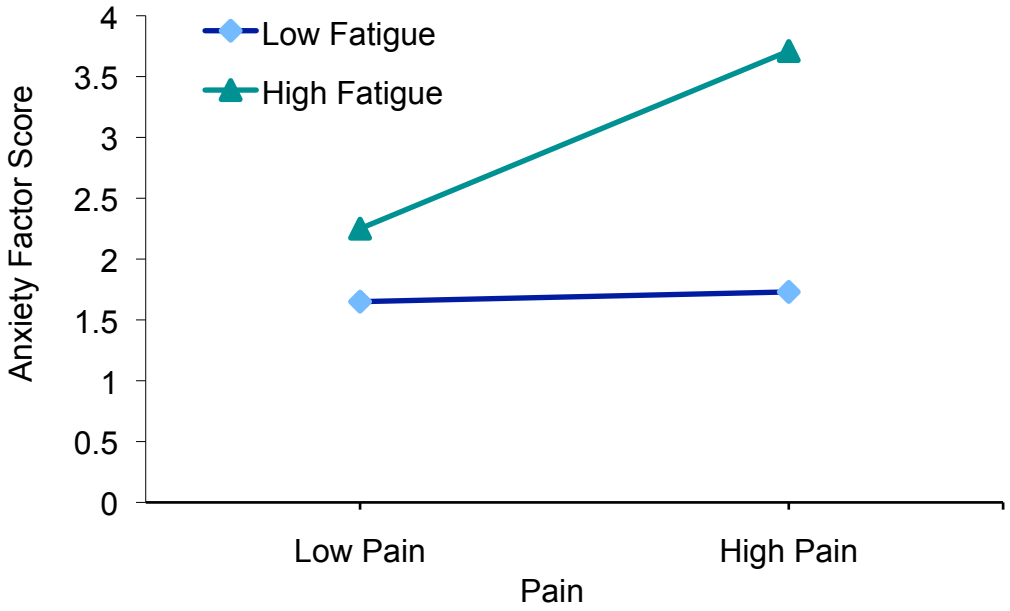

Figure 7.19. Interaction for initial pain & fatigue on the anxiety factor at 3 months.

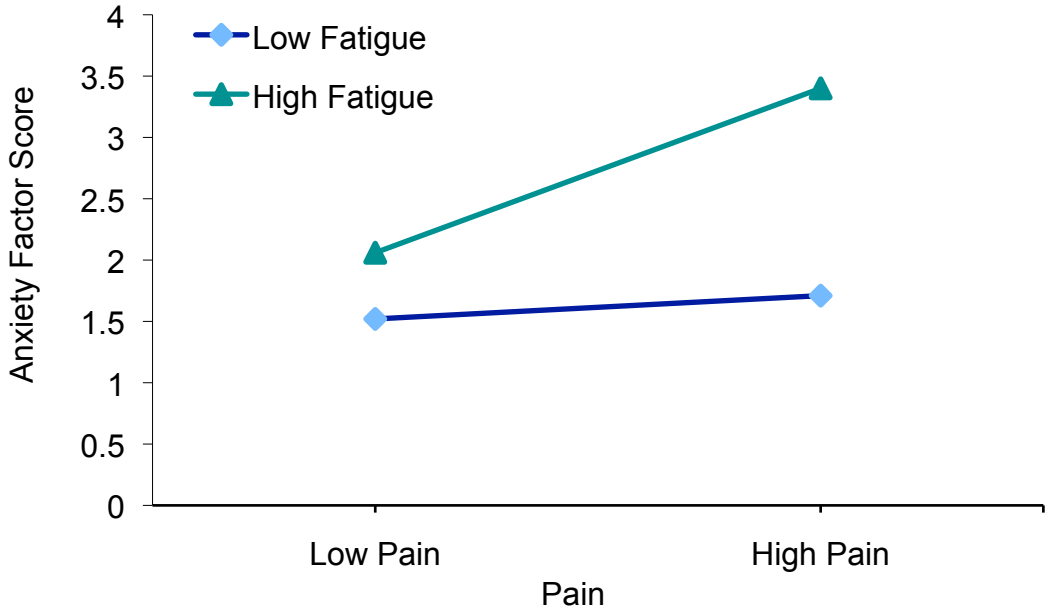

Figure 7.20. Interaction for initial pain & fatigue on the anxiety factor at 12 months.

7.3.7 Pre-injury Quality of Life

Cross-sectional sample. Independent samples *t*-tests were conducted to compare participants' HADS scores based on their pre-injury SQOL (Table 7.18). Two groups were included in the analyses, the high pre-injury SQOL group (QOLI score > 1.80) and the low pre-injury SQOL group (QOLI score < = 1.80). Pre-injury SQOL was determined by administering the QOLI at the initial follow-up, with post-injury SQOL measured at subsequent follow-ups.

Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 170 to 281 participants: high pre-injury SQOL (n = 40–59) and low pre-injury SQOL (n = 130–223; see Figure 7.1). Table D10 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figures 7.21, 7.22, and 7.23.

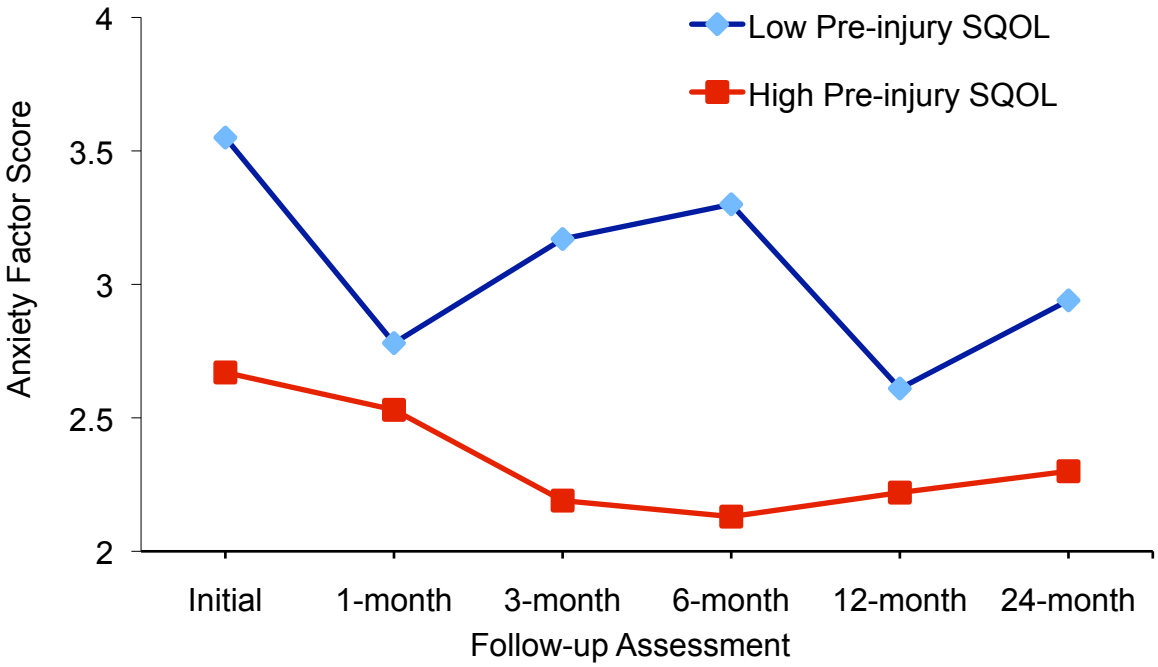

Figure 7.21. Mean anxiety factor scores over time for pre-injury QOLI (cross-sectional sample).

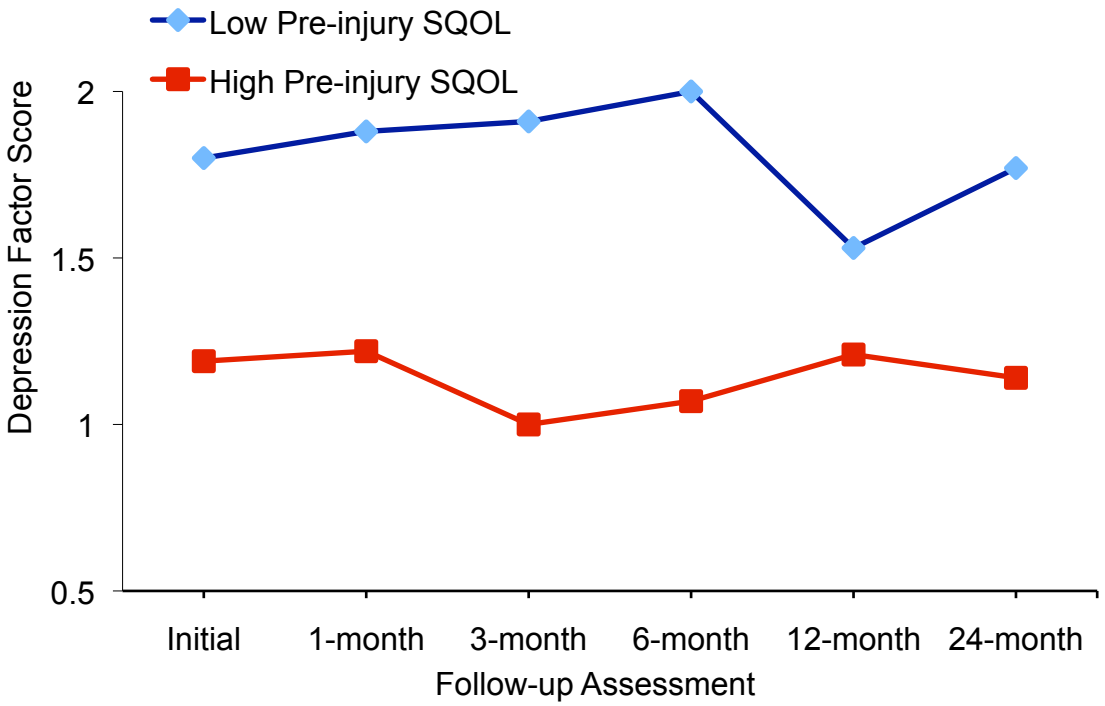

Figure 7.22. Mean depression factor scores over time for pre-injury QOLI (cross-sectional sample).

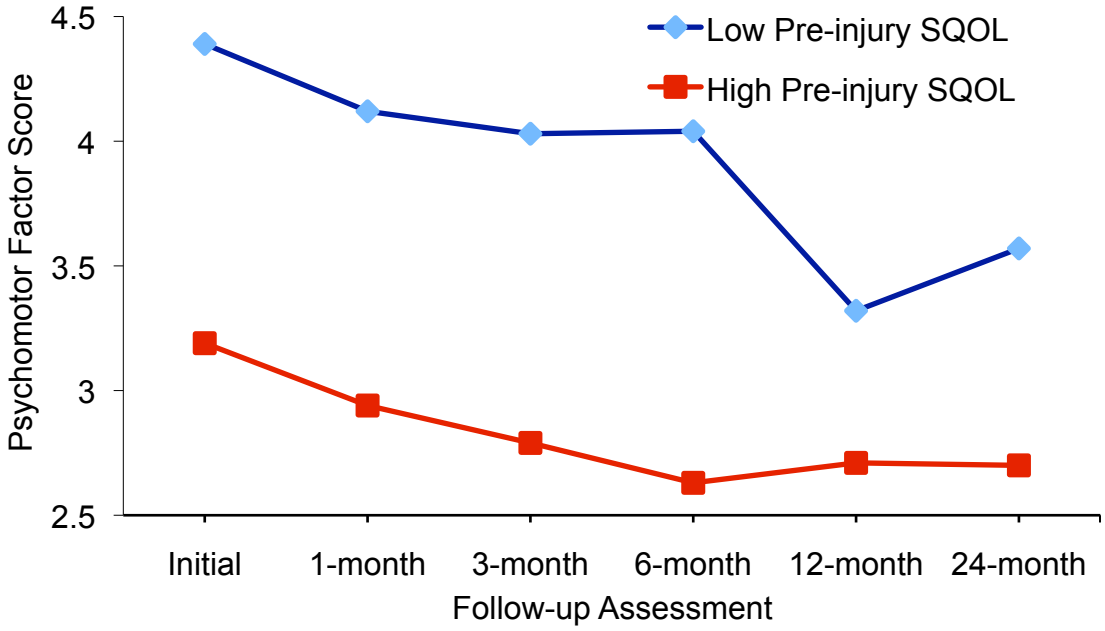

Figure 7.23. Mean psychomotor factor scores over time for pre-injury QOLI (cross-sectional sample).

Anxiety factor. On the Anxiety factor (Figure 7.21; Table 7.18), the low pre-injury SQOL group showed significantly higher mean scores than the high pre-injury SQOL group at the 3- and 6-month follow-ups ($p < .01$). There was a strong trend for the low pre-injury SQOL group to display a higher mean anxiety score than the high pre-injury SQOL group at the initial ($p = .058$) and 24-month ($p = .099$) follow-ups. Cohen's *d* showed a medium effect size at 6 months and small effect sizes at the other follow-ups.

Depression factor. On the Depression factor (Figure 7.22; Table 7.18), the low pre-injury SQOL group showed significantly higher mean scores than the high pre-injury SQOL group at the initial ($p < .05$), 1-month ($p < .05$), 3-month ($p < .001$), and 6-month ($p < .001$) follow-ups. There was a strong trend for the low pre-injury SQOL group to display a higher mean depression score than the high pre-injury SQOL group at 24 months ($p = .057$). Cohen's *d* showed medium effect sizes at 3 months, 6 months, and 24 months, and small effect sizes at the other follow-ups.

Psychomotor factor. On the Psychomotor factor (Figure 7.23; Table 7.18), the low pre-injury SQOL group showed significantly higher mean scores than the high pre-injury SQOL

group at the initial ($p < .001$), 1-month ($p < .01$), 3-month ($p < .001$), 6-month ($p < .001$), and 24-month ($p < .05$) follow-ups. Cohen's *d* showed medium effect sizes at 3 months and 6 months, and small effect sizes at the other follow-ups.

Table 7.18

Independent Samples t-Tests for Pre-injury QOLI (High, Low) on the HADS factors

Follow-up/ HADS Factor	*t*	*df*	*p*	Cohen's *d*	Power	Mean Difference	95% CI LL	95% CI UL
Initial (<15 days)								
Anxiety	1.93	64	.058	.48	.81	.88	-.03	1.79
Depression	2.27*	195	.024	.33	.49	.61	.08	1.14
Psychomotor	3.39***	195	.001	.49	.83	1.21	.50	1.91
1-month								
Anxiety	.61	168	.543	.09	.08	.24	-.54	1.02
Depression	2.19*	168	.030	.34	.46	.66	.06	1.26
Psychomotor	2.94**	168	.004	.45	.70	1.17	.38	1.96
3-month								
Anxiety	3.03**	279	.003	.36	.68	.98	.34	1.62
Depression	3.50***	73	.001	.82	1.00	.91	.39	1.43
Psychomotor	3.70***	79	< .001	.83	1.00	1.24	.57	1.91
6-month								
Anxiety	3.10**	81	.003	.69	1.00	1.16	.42	1.91
Depression	3.54***	76	.001	.81	1.00	.94	.41	1.46
Psychomotor	3.89***	80	< .001	.87	1.00	1.41	.69	2.13
12-month								
Anxiety	1.04	245	.301	.13	.13	.39	-.35	1.13
Depression	1.21	245	.226	.15	.16	.32	-.20	.84
Psychomotor	1.50	70	.139	.36	.63	.60	-.20	1.41
24-month								
Anxiety	1.66	219	.099	.22	.25	.64	-.12	1.39
Depression	1.95	55	.057	.53	.87	.63	-.02	1.27
Psychomotor	2.35*	219	.020	.32	.46	.86	.14	1.59

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

7.3.8 Quality of Life

Cross-sectional sample. Further independent samples *t*-tests were conducted to explore the impact of participants' SQOL (measured at the 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups) on HADS scores (Table 7.19). Two groups were included in the analyses, the high pre-injury SQOL group (QOLI score > 1.80) and the low pre-injury SQOL group (QOLI score < = 1.80). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 273 to 460 participants: low SQOL (*n* = 90–150) and high SQOL (*n* = 183–310; see Figure 7.1).

Table D11 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figure 7.24 (Anxiety factor) and Figures D7 and D8 in Appendix D (for the Depression and Psychomotor factors). For each of the HADS factors, the low SQOL group showed a significantly higher mean score than the high SQOL group at each follow-up ($p < .001$). Large effect sizes were noted using Cohen's *d*.

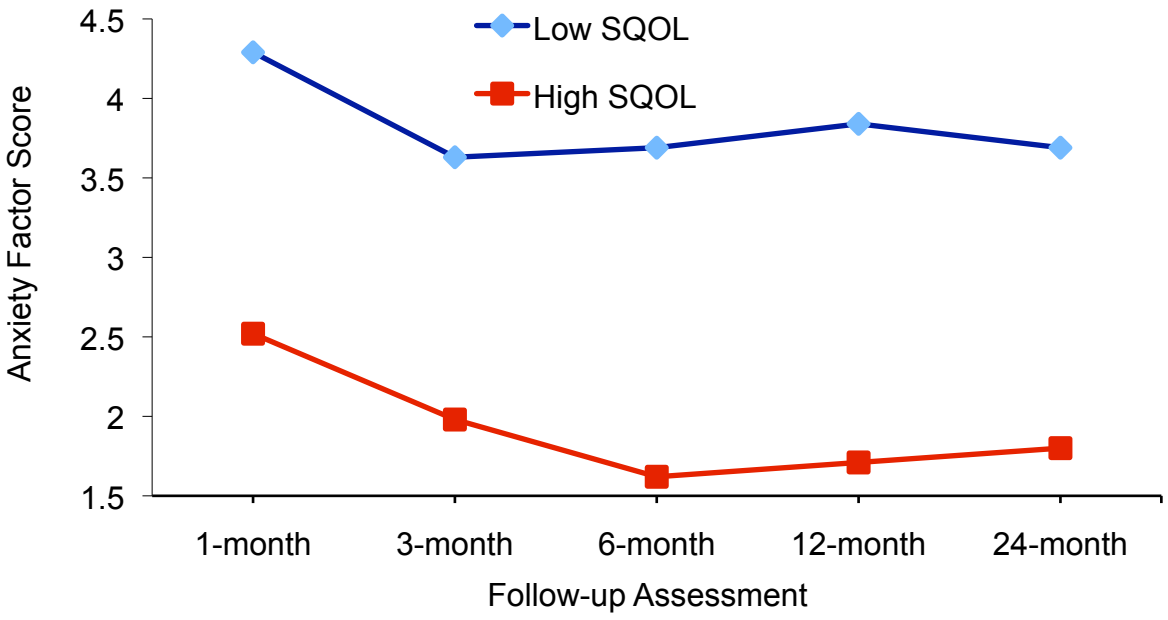

Figure 7.24. Mean anxiety factor scores over time for QOLI (cross-sectional sample).

Table 7.19

Independent Samples t-Tests for QOLI (Low, High) on the HADS factors

Follow-up/ HADS Factor	*t*	*df*	*p*	Cohen's *d*	Power	Mean Difference	95% CI LL	95% CI UL
1-month								
Anxiety	5.63***	154	< .001	.91	1.00	1.77	1.15	2.39
Depression	6.02***	131	< .001	1.05	1.00	1.37	.92	1.82
Psychomotor	5.64***	139	< .001	.96	1.00	1.61	1.04	2.17
3-month								
Anxiety	6.86***	254	< .001	.86	1.00	1.65	1.17	2.12
Depression	8.69***	230	< .001	1.15	1.00	1.34	1.04	1.64
Psychomotor	9.40***	265	< .001	1.15	1.00	1.92	1.52	2.32
6-month								
Anxiety	8.57***	211	< .001	1.18	1.00	2.07	1.60	2.55
Depression	10.75***	180	< .001	1.60	1.00	1.80	1.47	2.13
Psychomotor	11.29***	219	< .001	1.53	1.00	2.41	1.99	2.84
12-month								
Anxiety	7.41***	133	< .001	1.29	1.00	2.13	1.56	2.70
Depression	7.98***	125	< .001	1.43	1.00	1.59	1.19	1.98
Psychomotor	8.38***	132	< .001	1.46	1.00	2.19	1.67	2.71
24-month								
Anxiety	7.04***	131	< .001	1.23	1.00	1.89	1.36	2.42
Depression	9.19***	110	< .001	1.75	1.00	1.83	1.44	2.23
Psychomotor	9.24***	126	< .001	1.65	1.00	2.25	1.76	2.73

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Longitudinal sample. Mixed between & within subjects Repeated Measures ANOVAs were conducted to assess the impact of participants' SQOL on HADS scores across six time periods post-trauma (initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 80 participants who completed the QOLI at the 1-month follow-

up and the HADS at every follow-up assessment. Two groups were included in the analyses, low SQOL (n = 19) and high SQOL (n = 61). These groups were categorized as (low SQOL [QOLI score < = 1.80]; and high SQOL [QOLI score > 1.80]). Mean HADS factor scores and standard deviations are shown in Table D12 (Appendix D). The mean scores for each HADS factor are plotted over time in Figures D9, D10, and D11 (Appendix D).

Table 7.20 shows the tests of within-subjects for QOLI on the HADS factors. There were significant main effects for time since TBI on the Anxiety factor, $F(4, 228) = 3.39$, $p = .012$, $\eta^2_{partial} = .04$; Depression factor, $F(3, 256) = 6.46$, $p < .001$, $\eta^2_{partial} = .08$; and Psychomotor factor, $F(4, 321) = 6.96$, $p < .001$, $\eta^2_{partial} = .08$. These results indicate a significant reduction in participants' mean HADS scores over time. For the main effect of time, a small effect size was found on the Anxiety factor, and medium effect sizes for the Depression and Psychomotor factors.

Bonferroni post-hoc comparisons for time since TBI, for each of the HADS factors are displayed in 'Output – Study 3' (Appendix D on the CD). Table D13 (Appendix D) shows the post-hoc comparisons that were significant or indicated a trend for differences between follow-ups. There was a weak trend for differences in mean anxiety scores between the initial and 3-month follow-up (p = .082). Significant differences in mean anxiety scores were found between the initial and 6-month follow-up (p = .005), and the 1-month and 6-month follow-up (p = .023; see Figure D9). Significant differences in mean depression scores were found between the initial and 3-month follow-up (p = .005), the initial and 6-month follow-up (p = .002), the initial and 24-month follow-up (p = .033), and the 1-month and 6-month follow-up (p = .002; see Figure D10). Significant differences in mean psychomotor scores were found between the initial and 3-month follow-up (p = .016), the initial and 6-month follow-up (p < .001), the initial and 24-month follow-up (p = .003), 1-month and 6-month follow-up (p = .017), and the 1-month and 24-month follow-up (p = .045). There was a strong trend for a

difference in mean psychomotor scores between the initial and 12-month follow-up ($p = .065$; see Figure D11).

Tests of between-subjects effects for QOLI on the HADS factors are displayed in Table 7.20. The main effect comparing the two SQOL groups was highly significant for the Anxiety factor, $F(1, 78) = 13.78$, $p < .001$, $\eta^2_{partial} = .15$; Depression factor, $F(1, 78) = 16.80$, $p < .001$, $\eta^2_{partial} = .18$; and Psychomotor factor, $F(1, 78) = 17.57$, $p < .001$, $\eta^2_{partial} = .18$. For the main effect of QOLI, large effect sizes were found for each of the HADS factors. These results indicate participants with low SQOL scored significantly higher on the HADS factors compared with participants with high SQOL.

There was a significant Time x QOLI interaction on the Anxiety factor, $F(4, 288) = 2.98$, $p = .023$, $\eta^2_{partial} = .04$, indicating the low SQOL group showed an increase in mean anxiety scores between the 6-month and 12-month follow-ups, while the high SQOL group showed a slight decrease in mean anxiety scores between these two follow-up assessments. The low SQOL group showed a reduction in mean anxiety scores between the 12-month and 24-month follow-ups, while the high SQOL group showed an increase in mean anxiety scores between these two follow-up assessments.

There was a significant Time x QOLI interaction on the Depression factor, $F(3, 256) = 2.57$, $p = .050$, $\eta^2_{partial} = .03$, indicating the low SQOL group showed a decrease in mean depression scores between the 1-month and 3-month follow-ups, and between the 12-month and 24-month follow-ups, while the high SQOL group showed a very slight increase in mean depression scores between these follow-up assessments.

There was a trend for a Time x QOLI interaction on the Psychomotor factor, $F(4, 321) = 1.97$, $p = .096$, $\eta^2_{partial} = .03$, indicating the low SQOL group showed an increase in mean psychomotor scores between the 6-month and 12-month follow-ups, while the high SQOL group showed a slight decrease in mean psychomotor scores between these two follow-up

assessments. The low SQOL group showed a reduction in mean psychomotor scores between the 12-month and 24-month follow-ups, while the high SQOL group showed a slight increase in mean psychomotor scores between these two follow-up assessments. For the Time x QOLI interaction, small effect sizes were found for each of the HADS factors.

Table 7.20

Tests of Within-Subjects & Between-Subjects Effects for QOLI (Low/High) on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	288	3.39*	.012	.04	.83
QOLI	1	78	13.78***	< .001	.15	.96
Time x QOLI[a]	4	288	2.98*	.023	.04	.77
Depression						
Time since TBI[a]	3	256	6.46***	< .001	.08	.98
QOLI	1	78	16.80***	< .001	.18	.98
Time x QOLI[a]	3	256	2.57*	.050	.03	.66
Psychomotor						
Time since TBI[a]	4	321	6.96***	< .001	.08	1.00
QOLI	1	78	17.57***	< .001	.18	.99
Time x QOLI[a]	4	321	1.97	.096	.03	.60

Note. [a]Greenhouse-Geisser results are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

7.3.9 Initial Post-concussion Symptoms

Cross-sectional sample. One-way between-subjects ANOVAs were conducted at each follow-up assessment, to compare participants' HADS scores based upon their initial RPQ score (Table 7.21). The sample was split into four groups according to percentiles (25th, 50th, 75th, and > 75th percentile): minimal (RPQ score of 0–8), mild (RPQ score of 9–17), moderate (RPQ score of 18–27), and severe (RPQ score of 28+). At each follow-up, participants' HADS scores were analysed using their RPQ scores from the initial follow-up.

Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 375 to 584 participants: minimal RPQ (*n* = 87–155), mild RPQ (*n* = 109–156), moderate RPQ (*n* = 89–142), and severe RPQ (*n* = 90–145; see Figure 7.1). Table D14 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figure 7.25 (Anxiety factor) and Figures D12 and D13 in Appendix D (Depression and Psychomotor factors).

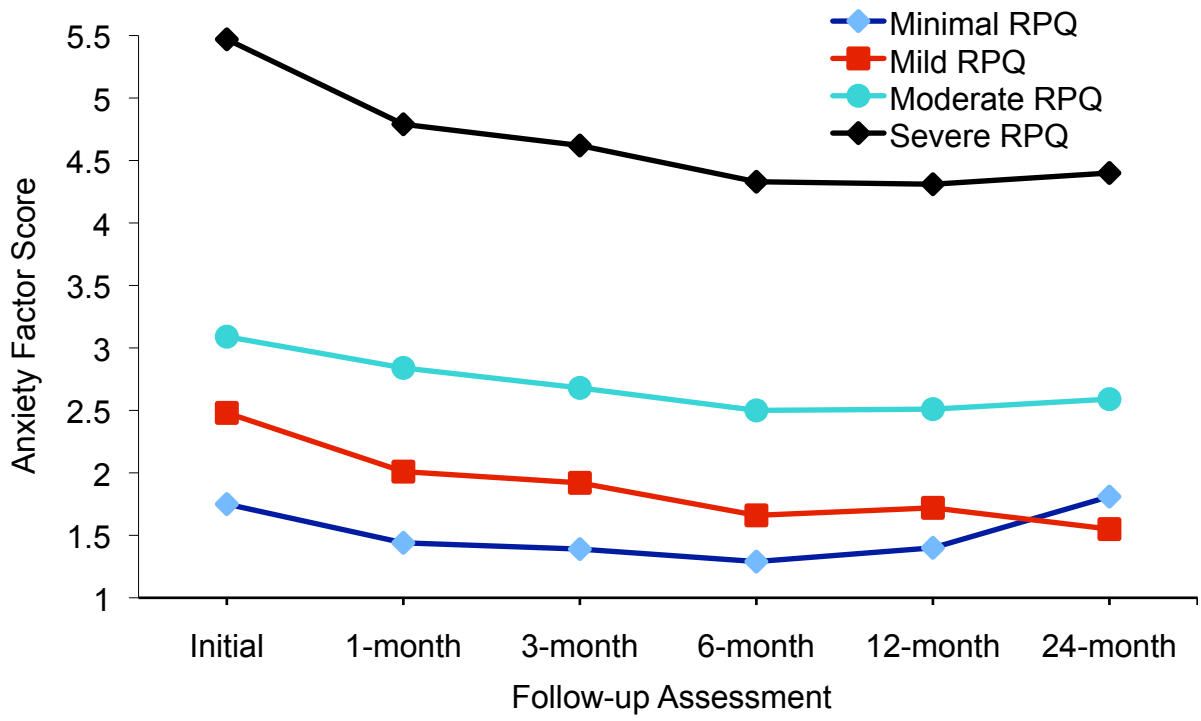

Figure 7.25. Mean anxiety factor scores for initial RPQ four groups (cross-sectional sample).

Anxiety factor. Highly significant differences in mean anxiety scores (Figure 7.25; Table 7.21) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated large effect sizes at each follow-up. Tukey post-hoc tests for each of the HADS factors are displayed in 'Output – Study 3' (Appendix D on the CD). Table 7.22 shows the post-hoc comparisons for the Anxiety factor that were significant or indicated a trend for differences between the initial RPQ groups. The severe RPQ group showed significantly higher mean anxiety scores than the minimal, mild, and moderate RPQ groups at each follow-up ($p < .001$). The moderate RPQ group reported significantly higher mean anxiety scores than the mild RPQ group at the 1-month ($p < .05$), 3-month ($p < .05$), 6-month ($p < .01$), 12-month ($p < .05$), and 24-month ($p < .001$) follow-ups. The moderate RPQ group displayed significantly higher mean anxiety scores than the minimal RPQ group at the 1-month ($p < .001$), 3-month ($p < .001$), 6-month ($p < .001$), 12-month ($p < .001$), and 24-month ($p < .05$) follow-ups. There was a trend for the mild RPQ group to show higher mean anxiety scores than the minimal RPQ group at the initial follow-up ($p = .051$; Figure 7.25).

Depression factor. Highly significant differences in mean depression scores (Figure D12 – Appendix D; Table 7.21) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated large effect sizes at each follow-up. Tukey post-hoc tests (Table 7.22) showed the severe RPQ group reported significantly higher mean depression scores than the minimal, mild, and moderate RPQ groups at each follow-up ($p < .001$). The moderate RPQ group displayed significantly higher mean depression scores than the minimal RPQ group at the initial ($p < .001$), 1-month ($p < .001$), 3-month ($p < .001$), 6-month ($p < .001$), and 12-month ($p < .05$) follow-ups. The moderate RPQ group displayed significantly higher mean depression scores than the mild RPQ group at the initial ($p < .001$), 1-month ($p < .001$), 3-month ($p < .01$), 6-month ($p < .001$), and 12-month ($p < .05$) follow-ups. There was a trend

for the moderate RPQ group to display higher mean depression scores than the mild RPQ group at the 24-month follow-up ($p = .099$; Figure D12 Appendix D).

Psychomotor factor. Highly significant differences in mean psychomotor scores (Figure D13 – Appendix D; Table 7.21) were found between the groups at each follow-up ($p < .001$). Large effect sizes were found at each follow-up. Tukey post-hoc tests (Table 7.22) showed the severe RPQ group reported significantly higher mean psychomotor scores than the minimal, mild, and moderate RPQ groups at each follow-up ($p < .001$). The moderate RPQ group displayed significantly higher mean psychomotor scores than the mild RPQ group at each follow-up ($p < .001$ at the initial, 1-month, 3-month, 6-month, and 24-month follow-ups; $p < .01$ at 12 months). The moderate RPQ group showed significantly higher mean psychomotor scores than the minimal RPQ group at the initial ($p < .001$), 1-month ($p < .001$), 3-month ($p < .001$), 6-month ($p < .001$), and 12-month ($p < .05$) follow-ups. The mild RPQ group showed a significantly higher mean psychomotor score than the minimal RPQ group at the initial follow-up ($p < .003$; Figure D13 – Appendix D).

Table 7.21

One-Way ANOVAs for RPQ (Four Groups) on the HADS – Cross-Sectional Sample

Follow-up/ HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Anxiety	3	477	65.46***	< .001	.29	1.00
Depression	3	477	63.24***	< .001	.28	1.00
Psychomotor	3	477	80.47***	< .001	.33	1.00
1-month						
Anxiety	3	371	46.71***	< .001	.28	1.00
Depression	3	371	33.89***	< .001	.22	1.00
Psychomotor	3	371	47.04***	< .001	.28	1.00
3-month						
Anxiety	3	580	61.31***	< .001	.24	1.00
Depression	3	580	44.51***	< .001	.19	1.00
Psychomotor	3	580	60.40***	< .001	.24	1.00
6-month						
Anxiety	3	578	59.10***	< .001	.24	1.00
Depression	3	578	46.88***	< .001	.20	1.00
Psychomotor	3	578	56.13***	< .001	.23	1.00
12-month						
Anxiety	3	489	40.69***	< .001	.20	1.00
Depression	3	489	36.35***	< .001	.19	1.00
Psychomotor	3	489	35.59***	< .001	.18	1.00
24-month						
Anxiety	3	457	39.73***	< .001	.21	1.00
Depression	3	457	26.86***	< .001	.15	1.00
Psychomotor	3	457	31.93***	< .001	.17	1.00

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.22

Significant/Trend Tukey Post-hoc Tests for RPQ on the HADS Factors – Cross-Sectional Sample

Follow-up	Pain Comparison	*Anxiety*		*Depression*		*Psychomotor*	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial (<15 days)	Mild & Minimal	.28	.051	–	–	.25	.003
Initial (<15 days)	Moderate & Minimal	.28	< .001	.19	< .001	.24	< .001
Initial (<15 days)	Moderate & Mild	–	–	.19	< .001	.24	< .001
Initial (<15 days)	Severe & Minimal	.28	< .001	.19	< .001	.25	< .001
Initial (<15 days)	Severe & Mild	.28	< .001	.19	< .001	.24	< .001
Initial (<15 days)	Severe & Moderate	.28	< .001	.19	< .001	.24	< .001
1-month	Moderate & Minimal	.31	< .001	.24	< .001	.31	< .001
1-month	Moderate & Mild	.29	.026	.22	.001	.30	< .001
1-month	Severe & Minimal	.31	< .001	.24	< .001	.31	< .001
1-month	Severe & Mild	.29	< .001	.22	< .001	.30	< .001
1-month	Severe & Moderate	.30	< .001	.23	< .001	.31	< .001
3-month	Moderate & Minimal	.25	< .001	.18	< .001	.23	< .001
3-month	Moderate & Mild	.25	.016	.18	.002	.23	< .001
3-month	Severe & Minimal	.25	< .001	.18	< .001	.23	< .001
3-month	Severe & Mild	.25	< .001	.18	< .001	.23	< .001
3-month	Severe & Moderate	.26	< .001	.18	< .001	.23	< .001
6-month	Moderate & Minimal	.25	< .001	.18	.001	.24	< .001
6-month	Moderate & Mild	.25	.004	.18	< .001	.24	< .001
6-month	Severe & Minimal	.25	< .001	.18	< .001	.24	< .001
6-month	Severe & Mild	.24	< .001	.18	< .001	.24	< .001
6-month	Severe & Moderate	.25	< .001	.18	< .001	.24	< .001
12-month	Moderate & Minimal	.28	< .001	.21	.049	.27	.012
12-month	Moderate & Mild	.28	.028	.21	.042	.27	.003
12-month	Severe & Minimal	.28	< .001	.21	< .001	.27	< .001
12-month	Severe & Mild	.28	< .001	.21	< .001	.27	< .001
12-month	Severe & Moderate	.29	< .001	.21	< .001	.28	< .001
24-month	Moderate & Minimal	.28	.028	–	–	–	–
24-month	Moderate & Mild	.28	.001	.22	.099	.27	.001
24-month	Severe & Minimal	.28	< .001	.22	< .001	.28	< .001
24-month	Severe & Mild	.29	< .001	.22	< .001	.28	< .001
24-month	Severe & Moderate	.29	< .001	.22	< .001	.28	< .001

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

7.3.10 Post-concussion Symptoms

Cross-sectional sample. Further one-way between-subjects ANOVAs were conducted to compare participants' HADS scores based upon their RPQ score measured at each follow-up (Table 7.23). Four groups were included in the analyses: minimal (RPQ score of 0–8), mild (RPQ score of 9–17), moderate (RPQ score of 18–27), and severe (RPQ score of 28+). Due to differing attendance rates post-injury, the number of TBI participants varied for each analysis, ranging from 369 to 587 participants: minimal (n = 116–277), mild (n = 80–135), moderate (n = 66–127), and severe (n = 67–119; see Figure 7.1). Table D15 (Appendix D) displays the mean HADS factor scores and standard deviations from these analyses. The mean scores for each HADS factor are plotted in Figures 7.26, 7.27, and 7.28.

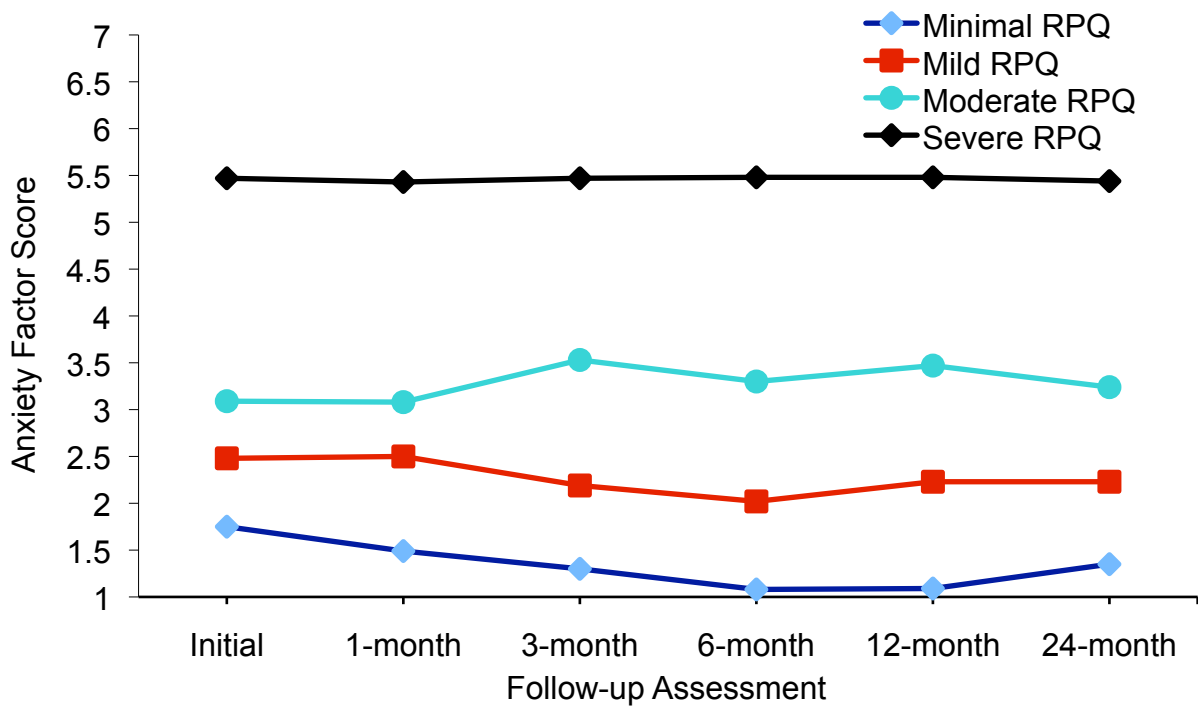

Figure 7.26. Mean anxiety factor scores for RPQ total score at each follow-up (cross-sectional sample).

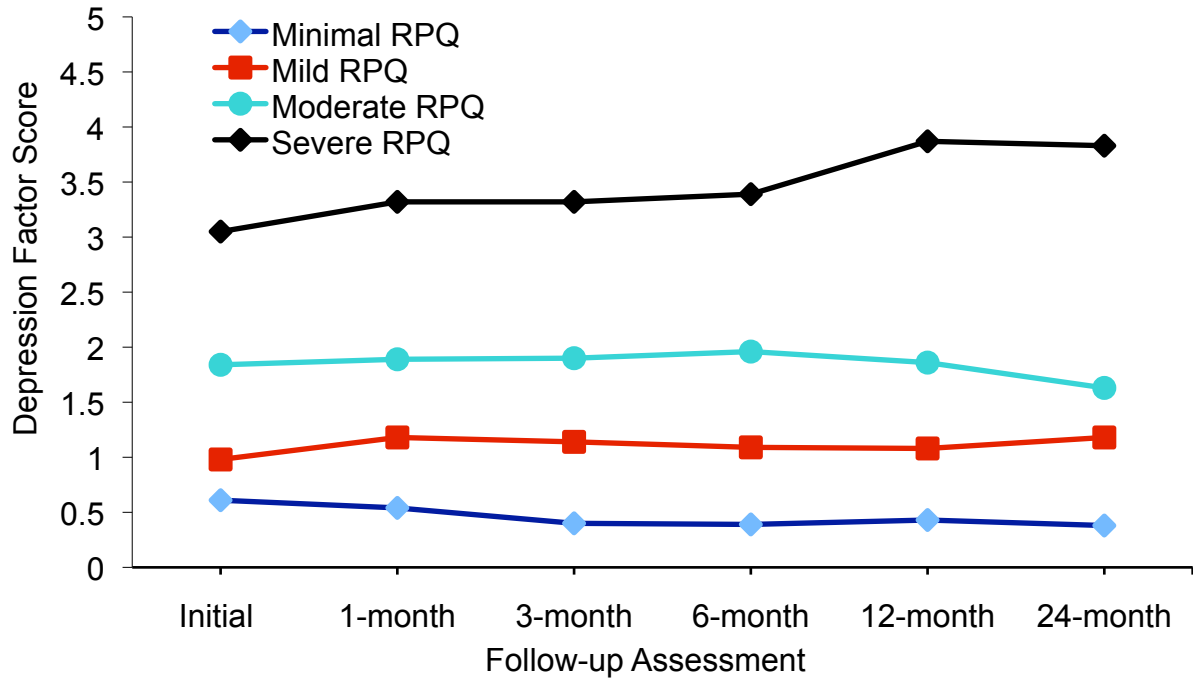

Figure 7.27. Mean depression factor scores for RPQ total score at each follow-up (cross-sectional sample).

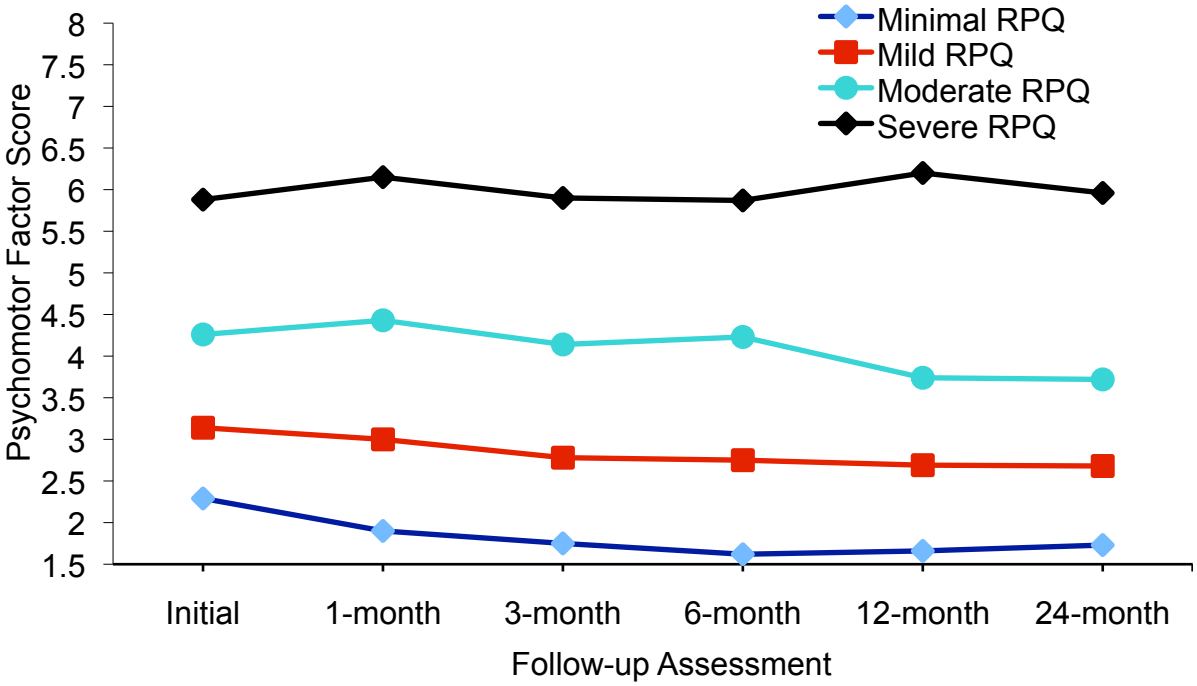

Figure 7.28. Mean psychomotor factor scores for RPQ total score at each follow-up (cross-sectional sample).

Anxiety factor. Highly significant differences in mean anxiety scores (Figure 7.26; Table 7.23) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated large effect sizes at each follow-up. Tukey post-hoc tests for each of the HADS factors are displayed in 'Output – Study 3' (Appendix D on the CD). Table 7.24 shows the post-hoc comparisons for the HADS factors that were significant or indicated a trend for differences between the RPQ groups. The severe RPQ group showed significantly higher mean anxiety scores than the minimal, mild, and moderate RPQ groups at each follow-up ($p < .001$).

The mild RPQ group showed significantly higher mean anxiety scores than the minimal RPQ group at the 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups ($p < .001$), and there was a trend for the mild RPQ group to report a higher mean anxiety score than the minimal RPQ group at the initial follow-up ($p = .051$). The moderate RPQ group displayed significantly higher mean anxiety scores than the minimal group at each follow-up ($p < .001$). The moderate RPQ group showed significantly higher mean anxiety scores than the mild RPQ group at the 3-month ($p < .001$), 6-month ($p < .001$), 12-month ($p < .001$), and 24-month ($p < .01$) follow-ups (Figure 7.26).

Depression factor. Highly significant differences in mean depression scores (Figure 7.27; Table 7.23) were found between the groups at each follow-up ($p < .001$). $\eta^2_{partial}$ indicated large effect sizes at each follow-up. Tukey post-hoc tests (Table 7.24) showed the severe RPQ group reported significantly higher mean depression scores than the minimal, mild, and moderate RPQ groups at each follow-up ($p < .001$). The moderate RPQ group reported significantly higher mean depression scores than the minimal RPQ group at each follow-up ($p < .001$). The moderate RPQ group displayed significantly higher mean depression scores than the mild RPQ group at each follow-up ($p < .01$ at 1 month; $p < .001$ at all other follow-ups). The mild RPQ group displayed significantly higher mean depression

scores than the minimal RPQ group at 1-month ($p < .01$), and the 3-month ($p < .001$), 6-month ($p < .001$), 12-month ($p < .001$), and 24-month ($p < .001$) follow-ups (Figure 7.27).

Psychomotor factor. Highly significant differences in mean psychomotor scores (Figure 7.28; Table 7.23) were found between the groups at each follow-up ($p < .001$). Large effect sizes were found at each follow-up. Tukey post-hoc tests (Table 7.24) showed the severe RPQ group reported significantly higher mean psychomotor scores than the minimal, mild, and moderate RPQ groups at each follow-up ($p < .001$). The mild RPQ group showed significantly higher psychomotor scores than the minimal RPQ group at each follow-up ($p < .01$ at the initial follow-up; $p < .001$ at all other follow-ups). The moderate RPQ group showed significantly higher mean psychomotor scores than the minimal and mild RPQ groups at each follow-up ($p < .001$; Figure 7.28).

Table 7.23

One-Way ANOVAs for RPQ (Four Groups) on the HADS – Cross-Sectional Sample

Follow-up/ HADS Factor	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Initial (<15 days)						
Anxiety	3	456	65.46***	< .001	.29	1.00
Depression	3	412	63.24***	< .001	.28	1.00
Psychomotor	3	459	81.73***	< .001	.33	1.00
1-month						
Anxiety	3	283	60.56***	< .001	.35	1.00
Depression	3	216	50.17***	< .001	.33	1.00
Psychomotor	3	365	86.20***	< .001	.41	1.00
3-month						
Anxiety	3	322	101.42***	< .001	.40	1.00
Depression	3	314	97.45***	< .001	.40	1.00
Psychomotor	3	577	174.11***	< .001	.48	1.00
6-month						
Anxiety	3	321	139.79***	< .001	.47	1.00
Depression	3	277	120.94***	< .001	.45	1.00
Psychomotor	3	317	164.66***	< .001	.51	1.00
12-month						
Anxiety	3	261	108.20***	< .001	.46	1.00
Depression	3	251	132.26***	< .001	.53	1.00
Psychomotor	3	275	156.07***	< .001	.53	1.00
24-month						
Anxiety	3	263	89.47***	< .001	.41	1.00
Depression	3	212	118.50***	< .001	.51	1.00
Psychomotor	3	249	121.45***	< .001	.48	1.00

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7.24

Significant/Trend Tukey Post-hoc Tests for RPQ on the HADS Factors – Cross-Sectional Sample

Follow-up	Pain Comparison	*Anxiety*		*Depression*		*Psychomotor*	
		SE	*p*	*SE*	*p*	*SE*	*p*
Initial (<15 days)	Mild & Minimal	.28	.051	–	–	.25	.003
Initial (<15 days)	Moderate & Minimal	.28	< .001	.19	< .001	.24	< .001
Initial (<15 days)	Moderate & Mild	–	–	.19	< .001	.24	< .001
Initial (<15 days)	Severe & Minimal	.28	< .001	.19	< .001	.25	< .001
Initial (<15 days)	Severe & Mild	.28	< .001	.19	< .001	.24	< .001
Initial (<15 days)	Severe & Moderate	.28	< .001	.19	< .001	.24	< .001
1-month	Mild & Minimal	.26	.001	.20	.007	.26	< .001
1-month	Moderate & Minimal	.27	< .001	.20	< .001	.27	< .001
1-month	Moderate & Mild	–	–	.23	.010	.30	< .001
1-month	Severe & Minimal	.28	< .001	.21	< .001	.28	< .001
1-month	Severe & Mild	.31	< .001	.23	< .001	.31	< .001
1-month	Severe & Moderate	.32	< .001	.24	< .001	.31	< .001
3-month	Mild & Minimal	.20	< .001	.14	< .001	.17	< .001
3-month	Moderate & Minimal	.24	< .001	.16	< .001	.20	< .001
3-month	Moderate & Mild	.26	< .001	.18	< .001	.22	< .001
3-month	Severe & Minimal	.22	< .001	.15	< .001	.19	< .001
3-month	Severe & Mild	.25	< .001	.17	< .001	.21	< .001
3-month	Severe & Moderate	.28	< .001	.19	< .001	.24	< .001
6-month	Mild & Minimal	.19	< .001	.14	< .001	.18	< .001
6-month	Moderate & Minimal	.24	< .001	.17	< .001	.22	< .001
6-month	Moderate & Mild	.27	< .001	.19	< .001	.25	< .001
6-month	Severe & Minimal	.20	< .001	.14	< .001	.18	< .001
6-month	Severe & Mild	.23	< .001	.16	< .001	.21	< .001
6-month	Severe & Moderate	.27	< .001	.19	< .001	.25	< .001

Follow-up	Pain Comparison	*Anxiety*		*Depression*		*Psychomotor*	
		SE	*p*	*SE*	*p*	*SE*	*p*
12-month	Mild & Minimal	.23	< .001	.15	< .001	.21	< .001
12-month	Moderate & Minimal	.25	< .001	.17	< .001	.22	< .001
12-month	Moderate & Mild	.30	< .001	.20	< .001	.27	< .001
12-month	Severe & Minimal	.22	< .001	.15	< .001	.20	< .001
12-month	Severe & Mild	.28	< .001	.19	< .001	.25	< .001
12-month	Severe & Moderate	.29	< .001	.20	< .001	.26	< .001
24-month	Mild & Minimal	.24	< .001	.16	< .001	.21	< .001
24-month	Moderate & Minimal	.26	< .001	.17	< .001	.23	< .001
24-month	Moderate & Mild	.31	.006	–	–	.27	.001
24-month	Severe & Minimal	.23	< .001	.16	< .001	.21	< .001
24-month	Severe & Mild	.28	< .001	.19	< .001	.26	< .001
24-month	Severe & Moderate	.30	< .001	.20	< .001	.27	< .001

Note. en dash (–) indicates no significant differences between the groups ($p > .05$).

Longitudinal sample. Mixed between & within subjects repeated measures ANOVAs were conducted to assess the impact of participants' RPQ scores on HADS scores across six time periods post-trauma (the initial, 1-month, 3-month, 6-month, 12-month, and 24-month follow-ups). The analyses included 100 participants who completed the RPQ at the initial follow-up and the HADS at each follow-up. The sample was split into four groups according to percentiles (25^{th}, 50^{th}, 75^{th}, and > 75^{th} percentile): minimal (RPQ score of 0–8; $n = 25$), mild (RPQ score of 9–17; $n = 32$), moderate (RPQ score of 18–27; $n = 29$), and severe (RPQ score of 28+; $n = 14$). Mean HADS factor scores and standard deviations are shown in Table D16 (Appendix D). The mean scores for each HADS factor are plotted over time in Figures 7.29, 7.30, and 7.31.

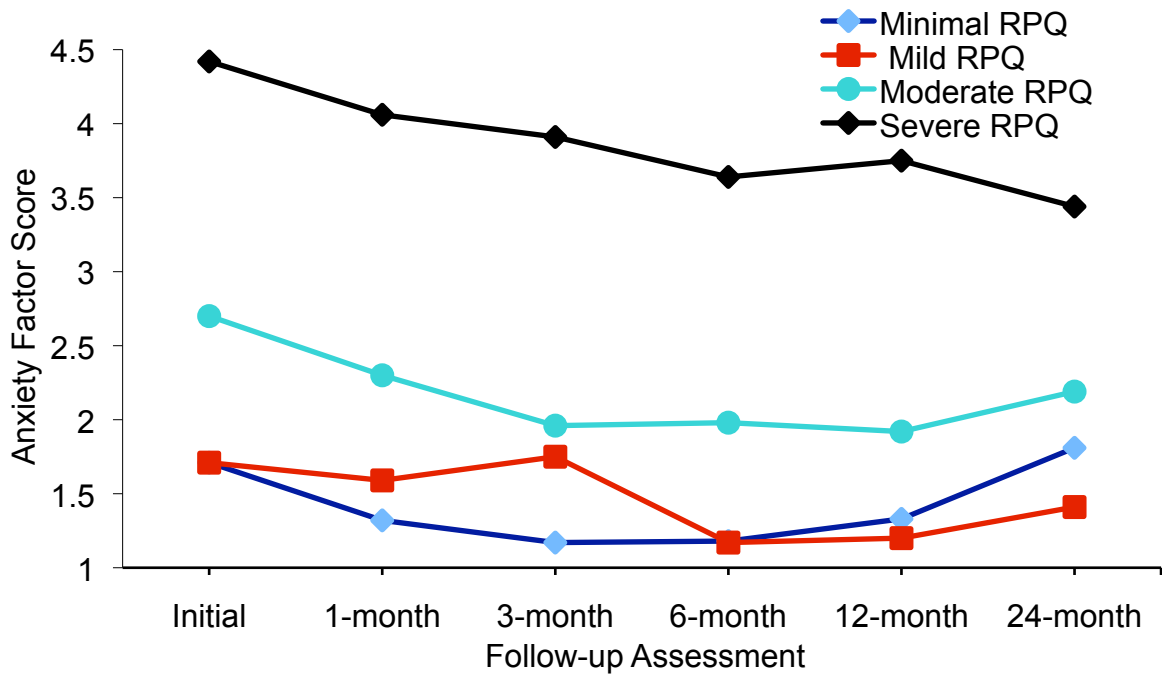

Figure 7.29. Mean anxiety factor scores for RPQ four groups (longitudinal sample).

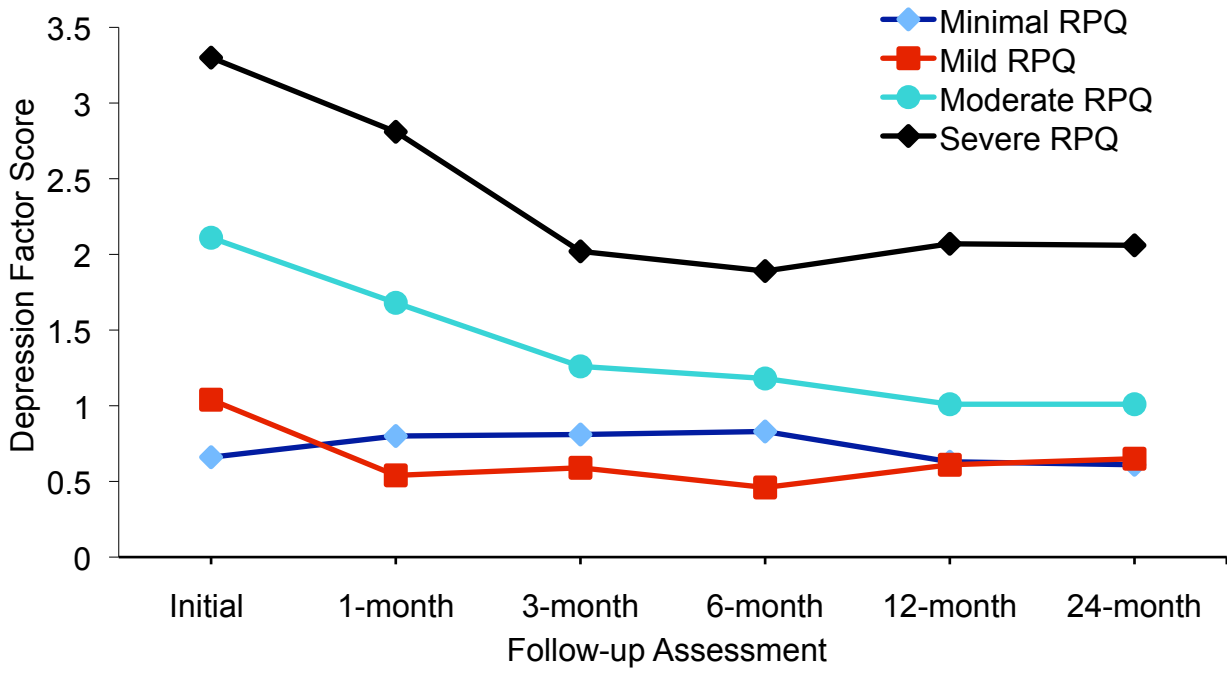

Figure 7.30. Mean depression factor scores for RPQ four groups (longitudinal sample).

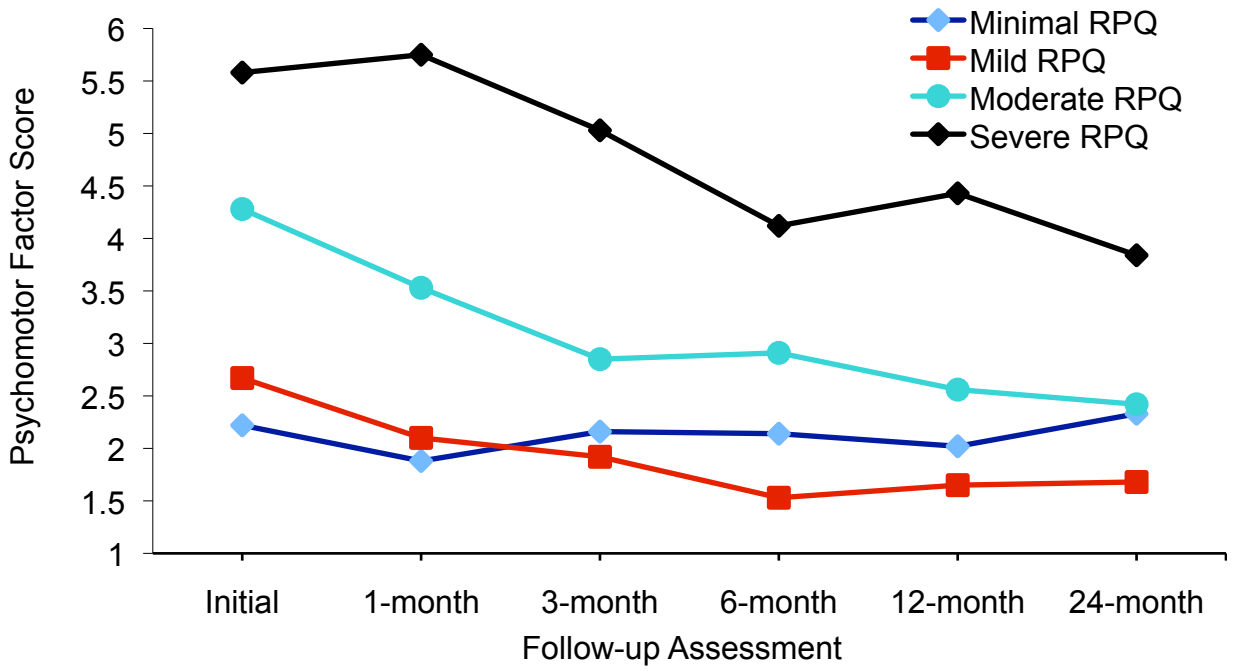

Figure 7.31. Mean psychomotor factor scores for RPQ four groups (longitudinal sample).

Table 7.25 shows the within-subjects effects for RPQ on the HADS factors. There was a main effect for time on the Anxiety factor, $F(4, 378) = 3.64$, $p = .007$, $\eta^2_{partial} = .04$; Depression factor, $F(4, 350) = 6.49$, $p < .001$, $\eta^2_{partial} = .06$; and Psychomotor factor, $F(4, 430) = 10.71$, $p < .001$, $\eta^2_{partial} = .10$. These results indicate a significant reduction in participants' mean HADS scores over time. The effect size for time was small on the Anxiety factor and medium on the Depression and Psychomotor factors.

Bonferroni post-hoc comparisons for time since injury, for each of the HADS factors are displayed in 'Output – Study 3' (Appendix D on the CD). Table D17 (Appendix D) shows the post-hoc comparisons that were significant or indicated a trend for differences between the follow-ups. Significant differences in mean anxiety scores were found between the initial and 6-month follow-up ($p = .003$), and the initial and 12-month follow-up ($p = .041$). Significant differences in mean depression scores were found between the initial and 3-month follow-up ($p = .009$), the initial and 6-month follow-up ($p = .002$), the initial and 12-month follow-up ($p = .015$), and the initial and 24-month follow-up ($p = .022$). There was a

trend for differences in mean depression scores between the 1-month and 6-month follow-up ($p = .079$), and the 1-month and 12-month follow-up ($p = .061$). Significant differences in mean psychomotor scores were found between the initial and 3-month follow-up ($p = .023$), the initial and 6-month follow-up ($p < .001$), the initial and 12-month follow-up ($p < .001$), and the initial and 24-month follow-up ($p < .001$). Significant differences in mean psychomotor scores were found between the 1-month and 6-month follow-up ($p = .006$), the 1-month and 12-month follow-up ($p = .003$), and the 1-month and 24-month follow-up ($p = .004$).

Tests of between-subjects effects for RPQ on the HADS factors are displayed in Table 7.25. The main effect comparing the four RPQ groups was highly significant for the Anxiety factor, $F(3, 96) = 9.22$, $p < .001$, $\eta^2_{\text{partial}} = .22$; Depression factor, $F(3, 96) = 10.33$, $p < .001$, $\eta^2_{\text{partial}} = .24$; and the Psychomotor factor, $F(3, 96) = 14.18$, $p < .001$, $\eta^2_{\text{partial}} = .31$. Very large effect sizes were found for each of the HADS factors. There was a moderate effect size for a significant Time x RPQ interaction on the Psychomotor factor, $F(13, 430) = 2.27$, $p = .006$, $\eta^2_{\text{partial}} = .07$, indicating participants in the minimal RPQ group reported an increase in psychomotor scores from the 12-month to 24-month follow-ups, while the severe RPQ group showed a decrease in psychomotor scores across these two follow-up assessments. No significant Time x RPQ interactions were found for the Anxiety factor, $F(12, 378) = .80$, $p = .648$, $\eta^2_{\text{partial}} = .02$, and the Depression factor, $F(11, 350) = 1.54$, $p = .116$, $\eta^2_{\text{partial}} = .02$.

Tukey post-hoc tests are displayed in the 'Output – Study 3' (Appendix D on the CD). Table 7.26 shows post-hoc tests that were significant or indicated a trend for differences between the initial RPQ groups. Participants in the severe RPQ group reported significantly higher mean Anxiety, Depression, and Psychomotor HADS factor scores than participants in the minimal ($p < .001$ for each HADS factor), mild ($p < .001$ for each HADS factor), and moderate ($p < .01$ for anxiety and psychomotor; $p < .05$ for depression) RPQ groups.

Participants in the moderate RPQ group reported significantly higher mean depression and psychomotor scores than the mild RPQ group ($p < .05$). There was a trend for the moderate RPQ group to show higher mean psychomotor scores than the minimum RPQ group ($p = .086$).

Table 7.25

Tests of Within-Subjects and Between-Subjects Effects for RPQ on the HADS Factors

HADS Factor/ Variable	*df* between	*df* within	*F*	*p*	$\eta^2_{partial}$	Power
Anxiety						
Time since TBI[a]	4	378	3.64**	.007	.04	.87
RPQ	3	96	9.22	< .001	.22	1.00
Time x RPQ[a]	12	378	.80	.648	.02	.47
Depression						
Time since TBI[a]	4	350	6.49***	< .001	.06	.99
RPQ	3	96	10.33***	< .001	.24	1.00
Time x RPQ[a]	11	350	1.54	.116	.05	.79
Psychomotor						
Time since TBI[a]	4	430	10.71***	< .001	.10	1.00
RPQ	3	96	14.18***	< .001	.31	1.00
Time x RPQ[a]	13	430	2.27***	.006	.07	.97

Note. [a]Greenhouse Geisser results are reported.
**$p < .01$. ***$p < .001$.

Table 7.26

Significant Between-Subjects Post-Hoc Tests: RPQ on the HADS Factors

HADS Factor/ Comparison	Mean Difference	*SE*	*p*	95% CI LL	95% CI UL
Anxiety					
Severe & Minimal	2.45	.52	< .001	1.09	3.81
Severe & Mild	2.40	.50	< .001	1.09	3.71
Severe & Moderate	1.70	.51	.006	.37	3.02
Depression					
Moderate & Mild	.73	.27	.041	.02	1.43
Severe & Minimal	1.63	.35	< .001	.72	2.55
Severe & Mild	1.71	.34	< .001	.83	2.59
Severe & Moderate	.98	.34	.026	.09	1.88
Psychomotor					
Moderate & Minimum	.97	.40	.086	-.09	2.02
Moderate & Mild	1.17	.38	.014	.18	2.16
Severe & Minimal	2.66	.49	< .001	1.37	3.95
Severe & Mild	2.87	.47	< .001	1.63	4.11
Severe & Moderate	1.70	.48	.004	.44	2.96

Note. Tukey post-hoc tests are reported.

7.3.11 Study 3 - Correlations

The relationship between the HADS Anxiety, Depression, and Psychomotor factors, post-concussion symptoms (as measured by RPQ total), and SQOL (as measured by QOLI total) was investigated at each follow-up assessment using Pearson product-moment correlation coefficients (Table 7.27). The relationship between the HADS Anxiety, Depression, and Psychomotor factors, pain, and fatigue was investigated at each follow-up using Spearman's rank correlation coefficient. At each follow-up, highly significant ($p < .001$) strong positive correlations were found between each set of the HADS factors. At each follow-up, highly significant ($p < .001$) strong positive correlations were found when correlating each of the HADS factors with RPQ total. At the initial follow-up, QOLI total showed a small correlation with each of the HADS factors. However, at all other follow-ups, medium to large negative correlations were found between QOLI total and each of the HADS factors. This suggests that higher HADS factor scores related to lower QOLI total scores.

At the initial follow-up, QOLI total showed a small correlation with RPQ total. Medium negative correlations were found between QOLI total and RPQ at 1 month, 3 months, and 12 months ($p < .001$), and strong negative correlations were found between QOLI total and RPQ total at 6 months and 24 months ($p < .001$). This suggests that higher RPQ total scores related to lower QOLI total scores.

Medium positive correlations were found when correlating each of the HADS factors with pain and fatigue at each follow-up ($p < .001$). A small correlation was found between pain and fatigue at 1 month, with medium positive correlations at all other follow-ups ($p < .001$).

Table 7.27

Means, Standard Deviations and Intercorrelations for HADS Factor Scores and Psychological/Physiological Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
Initial Follow-up									
1. Anxiety Factor	3.21	2.55	–						
2. Depression Factor	1.63	1.76	.60***	–					
3. Psychomotor Factor	3.90	2.29	.69***	.72***	–				
4. RPQ total	19.60	1.52	.56***	.56***	.62***	–			
5. QOLI total	2.81	2.72	-.17*	-.21**	-.25***	-.14	–		
6. Pain	3.63	2.72	.36***	.35***	.36***	–	–	–	
7. Fatigue	4.86	2.54	.37***	.39***	.37***	–	–	.44***	–
1-month									
1. Anxiety Factor	2.74	2.37	–						
2. Depression Factor	1.46	1.76	.60***	–					
3. Psychomotor Factor	3.41	2.44	.68***	.76***	–				
4. RPQ total	15.70	12.84	.61***	.58***	.66***	–			
5. QOLI total	2.27	1.78	-.40***	-.50***	-.53***	-.40***	–		
6. Pain	2.53	2.61	.37***	.31***	.38***	–	–	–	
7. Fatigue	4.33	2.57	.35***	.40***	.40***	–	–	.27***	–
3-month									
1. Anxiety Factor	2.60	2.46	–						
2. Depression Factor	1.34	1.68	.62***	–					
3. Psychomotor Factor	3.12	2.23	.74***	.75***	–				
4. RPQ total	14.34	13.28	.67***	.64***	.72***	–			
5. QOLI total	2.43	1.73	-.36***	-.50***	-.47***	-.38***	–		
6. Pain	2.42	2.76	.33***	.40***	.45***	–	–	–	
7. Fatigue	4.24	2.76	.40***	.39***	.46***	–	–	.40***	–

Variable	*M*	*SD*	1	2	3	4	5	6	7
6-month									
1. Anxiety Factor	2.42	2.43	–						
2. Depression Factor	1.32	1.70	.64***	–					
3. Psychomotor Factor	3.03	2.31	.75***	.77***	–				
4. RPQ total	13.84	13.84	.72***	.71***	.75***	–			
5. QOLI total	2.49	2.58	-.49***	-.62***	-.61***	-.52***	–		
6. Pain	2.13	2.63	.39***	.36***	.41***	–	–	–	
7. Fatigue	4.06	1.68	.39***	.35***	.41***	–	–	.34***	–
12-month									
1. Anxiety Factor	2.43	2.46	–						
2. Depression Factor	1.37	1.78	.68***	–					
3. Psychomotor Factor	2.94	2.30	.77***	.78***	–				
4. RPQ total	12.95	14.00	.72***	.75***	.76***	–			
5. QOLI total	2.14	2.75	-.41***	-.53***	-.52***	-.42***	–		
6. Pain	4.13	2.65	.43***	.44***	.46***	–	–	–	
7. Fatigue	2.64	1.78	.41***	.36***	.41***	–	–	.34***	–
24-month									
1. Anxiety Factor	2.54	2.40	–						
2. Depression Factor	1.34	1.79	.68***	–					
3. Psychomotor Factor	2.96	2.30	.77***	.77***	–				
4. RPQ total	12.96	13.68	.68***	.74***	.73***	–			
5. QOLI total	1.82	2.48	-.45***	-.60***	-.57***	-.52***	–		
6. Pain	4.03	2.62	.32***	.38***	.38***	–	–	–	
7. Fatigue	2.68	1.58	.34***	.33***	.35***	–	–	.32***	–

Note. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

7.3.12 Using Initial Psychological/Physiological Variables to Predict HADS Scores.

A series of stepwise multiple regression analyses were conducted to assess the ability of a number of psychological/physiological variables from the initial assessment to predict participants' HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI. The predictor variables included in the analyses are listed in Section 7.2.4. Sample sizes are displayed in 'Output – Study 3' (Appendix D on the CD) and varied according to the follow-up assessment and the variable measured (N = 93–280 participants). Each of the stepwise regression analyses is displayed in Table D18, D19, D20, and D21 (Appendix D). The final prediction models and the accompanying regression equations are presented in Table 7.29

Correlations. Means, standard deviations, and Pearson correlation coefficients for the regression analyses predicting HADS scores from initial psychological/physiological variables, are shown in Table 7.28. The initial HADS Anxiety factor showed large correlations with the Anxiety factor at all follow-ups; a large correlation with the Depression and Psychomotor factors at 3 months; and medium correlations with the Depression and Psychomotor factors at 6, 12, and 24 months post-injury. The initial HADS Depression factor displayed medium correlations with the Anxiety and Psychomotor factors at each follow-up; a large correlation with the Depression factor at 3 months; and medium correlations with the Depression factor at 6, 12, and 24 months. The initial HADS Psychomotor factor showed a large correlation with the Anxiety factor at 3 months and medium correlations with the Anxiety factor at 6, 12, and 24 months; medium correlations with the Depression factor at each follow-up; large correlations with the Psychomotor factor at 3 and 6 months, and medium correlations with the Psychomotor factor at 12 and 24 months post-TBI.

Pain displayed medium sized correlations with the Anxiety factor at 3 months, 12 months, and 24 months; and medium correlations with the Psychomotor factor at 3 months

and 24 months. Fatigue displayed medium correlations with the Anxiety, Depression, and Psychomotor factors at 3 months. Medium correlations were found between RPQ and each of the HADS factors at all follow-ups. Medium sized negative correlations were found between QOLI and the Depression factor at 3 and 6 months, and QOLI and the Psychomotor factor at 6 months.

Table 7.28

Means, Standard Deviations and Correlations for Initial Psychological/Physiological Predictor Variables and the HADS Factor Scores

Variable	*M*	*SD*	Anxiety Factor	Depression Factor	Psychomotor Factor	Pain	Fatigue	QOLI	RPQ
Anxiety									
3-months	2.48	2.40	.68***	.44***	.50***	.36***	.31***	-.22**	.49***
6-months	1.99	2.16	.62***	.36***	.43***	.29***	.19***	-.22**	.40***
12-months	2.02	2.16	.53***	.34***	.43***	.34***	.25***	-.04	.40***
24-months	2.33	2.29	.57***	.31***	.45***	.32***	.24***	-.19*	.39***
Depression									
3-months	1.16	1.59	.51***	.56***	.47***	.27***	.31***	-.33***	.40***
6-months	1.00	1.51	.38***	.46***	.40***	.18**	.15**	-.32***	.36***
12-months	1.03	1.56	.36***	.39***	.41***	.22***	.16**	-.07	.36***
24-months	.19	1.75	.41***	.32***	.40***	.23***	.19**	-.14	.34***
Psychomotor									
3-months	2.97	2.22	.54***	.44***	.56***	.32***	.31***	-.27***	.47***
6-months	2.57	2.04	.48***	.45***	.54***	.19**	.24***	-.32***	.43***
12-months	2.53	2.14	.40***	.31***	.47***	.26***	.18**	-.12	.39***
24-months	2.67	2.27	.43***	.31***	.45***	.32***	.17**	-.20*	.31***

Note. Pearson Correlation Coefficients are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

Anxiety factor. Four regression models were produced for predicting HADS anxiety scores at 3 months (Table 7.29). The initial HADS Anxiety factor was entered at Step 1, explaining 46% of the variance in anxiety. QOLI was added to the model in Step 2, the total variance explained by the model as a whole was 50%. In Step 3, RPQ was added to the model, increasing the total variance explained to 53%. The final model consisted of the predictors the initial HADS Anxiety factor, QOLI, RPQ, and pain (3 groups), and explained 54% of the variance in anxiety scores at 3 months ($R^2 = .54$, $F = 34.63$ [4, 116], $p < .001$). Of the four variables, the initial HADS Anxiety factor made the largest unique contribution to the model ($\beta = .55$), with QOLI ($\beta = -.18$) and RPQ ($\beta = .16$) also providing statistically significant contributions. There was a trend for pain (3 groups; $\beta = .13$) to provide a statistically significant contribution to the model.

Three regression models were produced for predicting HADS anxiety scores at 6 months (Table 7.29). The initial HADS Anxiety factor was entered at Step 1, explaining 38% of the variance in anxiety. QOLI (2 groups) was added to the model in Step 2, the total variance explained by the model as a whole was 43%. The final model consisted of the predictors the initial HADS Anxiety factor, QOLI, (2 groups), and pain (3 groups), and explained 45% of the variance in anxiety scores at 6 months ($R^2 = .45$, $F = 30.08$ [3, 110], $p < .001$). Of the three variables, the initial HADS Anxiety factor made the largest unique contribution to the model ($\beta = .56$). However, QOLI (2 groups; $\beta = -.22$) and pain (3 groups; $\beta = .15$) also provided statistically significant contributions to the model.

Two regression models were produced for predicting HADS anxiety scores at 12 months (Table 7.29). The initial HADS Anxiety factor was entered at Step 1, explaining 28% of the variance in anxiety. The final model consisted of the initial HADS Anxiety factor and pain, and explained 32% of the variance in anxiety scores at 12 months ($R^2 = .32$, $F = 24.26$

[2, 101], $p < .001$). The initial HADS Anxiety factor made the largest unique contribution to the model (β = .47), with pain also providing a statistically significant contribution (β = .22).

Two regression models were produced for predicting HADS anxiety scores at 24 months (Table 7.29). The initial HADS Anxiety factor was entered at Step 1, explaining 32% of the variance in anxiety. The final model consisted of the initial HADS Anxiety factor and pain, and explained 35% of the variance in anxiety scores at 12 months ($R^2 = .32$, $F = 23.59$ [2, 88], $p < .001$). The initial HADS Anxiety factor made the largest unique contribution to the model (β = .52), with pain also providing a statistically significant contribution (β = .17).

Depression factor. Three regression models were produced for predicting HADS depression scores at 3-months (Table 7.29). The initial HADS Depression factor was entered at Step 1, explaining 31% of the variance in depression. QOLI was added to the model in Step 2, the total variance explained by the model as a whole was 39%. The final model consisted of the predictors the initial HADS Depression factor, QOLI, and the initial HADS Anxiety factor, and explained 46% of the variance in depression scores at 3 months ($R^2 = .46$, $F = 33.19$ [3, 117], $p < .001$). The initial HADS Depression factor made the largest unique contribution to the model (β = .35). However, QOLI (β = -.30) and the initial HADS Anxiety factor (β = .31) also provided a statistically significant contribution.

Three regression models were produced for predicting HADS depression scores at 6 months (Table 7.29). The initial HADS Depression factor was entered at Step 1, explaining 21% of the variance in depression. QOLI was added to the model in Step 2, the total variance explained by the model as a whole was 28%. The final model consisted of the predictors the initial HADS Depression factor, QOLI, and the initial HADS Anxiety factor, and explained 30% of the variance in depression scores at 6 months ($R^2 = .30$, $F = 15.41$ [3, 110], $p < .001$). The initial HADS Depression factor made the largest unique contribution to the model (β = -.33), with QOLI (β = -.25) also providing a statistically significant contribution. There was a

trend for the initial HADS Anxiety factor (β = .17) to provide a contribution to the model (*p* = .075).

Two regression models were produced for predicting HADS depression scores at 12 months (Table D19 – Appendix D). The best model (Table 7.29) was found at Step 1 and consisted of the initial HADS Psychomotor factor, explaining 17% of the variance in depression (R^2 = .17, *F* = 20.72 [1, 102], *p* < .001). Although RPQ was included in Step 2 of the model and explained an additional 2% of the variance, it did not reach statistical significance (*p* = .098).

Two regression models were produced for predicting HADS depression scores at 24 months (Table 7.29). The initial HADS Anxiety factor was entered at Step 1, explaining 17% of the variance in depression. The final model consisted of the predictors the initial HADS Anxiety and Psychomotor factor, and explained 20% of the variance in depression scores at 24 months (R^2 = .20, *F* = 10.91 [2, 88], *p* < .001). The initial HADS Anxiety factor made the largest unique contribution to the model (β = .25). There was a trend for the initial HADS Psychomotor factor (β = -.24) to provide a contribution (*p* = .061).

Psychomotor factor. Five regression models were produced for predicting HADS psychomotor scores at 3 months (Table D20 – Appendix D). The best model (Table 7.29) consisted of the initial HADS Psychomotor and Anxiety factors, QOLI, and pain (3 groups), explaining 44% of the variance in psychomotor (R^2 = .44, *F* = 22.82 [4, 116], *p* < .001). Of the four variables, the initial HADS psychomotor (β = .28) and Anxiety factors (β = .31) made the largest unique contributions to the model, with QOLI (β = -.22) and pain (3 groups (β = .16) also providing significant contributions. Although RPQ was included in Step 5 of the model and explained an additional 2% of the variance, it did not reach statistical significance (*p* = .081).

Three models were produced for predicting HADS psychomotor scores at 6 months (Table 7.29). The initial HADS Psychomotor factors was entered at Step 1, explaining 29% of the variance in psychomotor scores at 6 months. QOLI was added to the model in Step 2, the total variance explained by the model as a whole was 33%. The final model consisted of the predictors the initial HADS Psychomotor factor, fatigue, and the initial HADS Anxiety factor, and explained 37% of the variance in psychomotor scores at 6 months (R^2 = .37, F = 21.39 [3, 110], p < .001). The initial HADS Psychomotor factor made the largest unique contribution to the model (β = .34). However, QOLI (β = -.22) and the initial HADS Anxiety factor (β = .24) also provided statistically significant contributions.

Two models were produced for predicting HADS psychomotor scores at 12 months (Table D21 – Appendix D). The best model consisted of the initial HADS Psychomotor factor entered at Step 1, explaining 22% of the variance in psychomotor (R^2 = .22, F = 28.55 [1, 102], p < .001). Although RPQ was included in Step 2 of the model and explained an additional 2% of the variance, it did not reach statistical significance (p = .099).

Three models were produced for predicting HADS psychomotor scores at 24 months (Table D21 – Appendix D). The best model (Table 7.29) consisted of the initial HADS Psychomotor factor and pain, explaining 25% of the variance in psychomotor (R^2 = .25, F = 14.54 [2, 88], p < .001). Of the two variables, the initial HADS Psychomotor factor made the largest unique contribution to the model (β = .41), however pain (β = .21) also provided a significant contribution. Although the initial HADS Anxiety factor was included in the model in Step 3 and explained an additional 2% of the variance, it did not reach statistical significance (p = .087).

Table 7.29

Final Regression Models for Predicting HADS Factor Scores Using Initial Complete Psychological/Physiological Variables

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	Anxiety Factor	.55	.07	.55	7.49	< .001	*Y* = .55 + .55 (Anxiety Factor)
	QOLI	-.35	.12	-.18	-2.92	.004	+ -.35 (QOLI) + .03 (RPQ)
	RPQ	.03	.01	.16	2.19	.030	+ .51 (Pain 3 groups)
	Pain (3 groups	.51	.26	.13	1.96	.052	
	6-months						
	Anxiety Factor	.53	.07	.56	7.63	< .001	*Y* = 1.76 + .53 (Anxiety Factor)
	QOLI (2 groups)	-1.14	.37	-.22	-3.11	.002	+ -1.14 (QOLI 2 groups)
	Pain (3 groups)	.53	.26	.15	2.04	.044	+ .53 (Pain 3 groups)
	12-months						
	Anxiety Factor	.44	.08	.47	5.61	< .001	*Y* = .19 + .44 (Anxiety Factor)
	Pain	.17	.07	.22	2.62	.010	+ .17 (Pain)
	24-months						
	Anxiety Factor	.50	.09	.52	5.80	< .001	*Y* = .35 + .50 (Anxiety Factor)
	Pain	.15	.08	.17	1.93	.057	+ .15 (Pain)
Depression	3-months						
	Depression Factor	.35	.08	.35	4.30	< .001	*Y* = 1.12 + .35 (Depression Factor)
	QOLI	-.37	.09	-.30	-4.31	< .001	+ -.37 (QOLI)
	Anxiety Factor	.21	.05	.31	3.83	< .001	+ .21 (Anxiety Factor)
	6-months						
	Depression Factor	.29	.09	.33	3.34	.001	*Y* = .97 + .29 (Depression Factor)
	QOLI	-.26	.09	-.25	-3.09	.003	+ -.26 (QOLI)
	Anxiety Factor	.11	.06	.17	1.80	.075	+ .11 (Anxiety Factor)

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Depression	12-months						
	Psychomotor Factor	.31	.07	.41	4.55	< .001	*Y* = .31 + .31 (Psychomotor Factor)
	24-months						
	Anxiety Factor	.19	.09	.25	2.04	.045	*Y* = -.10 + .19 (Anxiety Factor)
	Psychomotor Factor	.20	.10	.24	1.90	.061	+ .20 (Psychomotor Factor)
Psychomotor	3-months						
	Psychomotor Factor	.29	.10	.28	2.95	.004	*Y* = 1.36 + .29 (Psychomotor Factor)
	Anxiety Factor	.28	.09	.31	3.29	.001	+ .28 (Anxiety Factor)
	QOLI	-.39	.13	-.22	-3.10	.002	+ -.39 (QOLI)
	Pain (3 groups)	.56	.26	.16	2.14	.034	+ .56 (Pain 3 groups)
	6-months						
	Psychomotor Factor	.33	.09	.34	3.44	.001	*Y* = 1.68 + .33 (Psychomotor Factor)
	QOLI	-.32	.11	-.22	-2.89	.005	+ -.32 (QOLI)
	Anxiety Factor	.21	.09	.24	2.44	.016	+ .21 (Anxiety Factor)
	12-months						
	Psychomotor Factor	.48	.09	.47	5.34	< .001	*Y* = .79 + .48 (Psychomotor Factor)
	24-months						
	Psychomotor Factor	.44	.10	.41	4.32	< .001	*Y* = -.11 + .44 (Psychomotor Factor)
	Pain	.73	.33	.21	2.21	.029	+ .73 (Pain)

Excluding the HADS variables as predictors. A further series of stepwise multiple regression analyses were conducted to assess the ability of the psychological/physiological variables measured at the initial follow-up to predict HADS variables at the later follow-ups. In this series of analyses, the HADS factors were removed as predictor variables. Sample sizes varied according to the follow-up assessment and the variable measured (N = 93–286 participants; see 'Output – Study 3' in Appendix D on the CD). Each of the stepwise regression analyses is displayed in Table D22, D23, and D24 (Appendix D). The final prediction models and the accompanying regression equations are presented in Table 7.30.

Anxiety factor. Four regression models were produced for predicting HADS anxiety scores at 3 months (Table D22 – Appendix D). The best model consisted of RPQ, pain (3 groups), and QOLI, explaining 32% of the variance in anxiety (R^2 = .32, F = 18.75 [3, 118], p < .001). Of the three variables, RPQ provided the largest unique contribution to the model (β = .40), however, pain (3 groups; β = .23) and QOLI (β = -.18) also provided significant contributions. Although pain (2 groups) was included in Step 4 of the model and explained an additional 2% of the variance, it did not reach statistical significance (p = .137).

Three regression models were produced for predicting HADS anxiety scores at 6 months (Table 7.30). RPQ was entered at Step 1, explaining 16% of the variance in anxiety. QOLI (4 groups) was added to the model in Step 2, the total variance explained by the model as a whole was 20%. The final model consisted of the predictors RPQ, QOLI (4 groups), and pain (3 groups), and explained 25% of the variance in anxiety scores at 6 months (R^2 = .25, F = 11.88 [3, 110], p < .001). Of the three variables, RPQ made the largest unique contribution to the model (β = .29), however QOLI (4 groups) (β = - .23) and pain (3 groups) (β = .21) also made statistically significant contributions.

Two regression models were produced for predicting HADS anxiety scores at 12 months (Table 7.30). RPQ was entered at Step 1, explaining 16% of the variance in anxiety.

Pain was added to the model in Step 2, the total variance explained by the model as a whole was 21% (R^2 = .21, F = 13.75 [2, 101], p < .001). Of the two variables, RPQ made the largest unique contribution to the model (β = .33), however pain also made a statistically significant contribution (β = .24).

Three regression models were produced for predicting HADS anxiety scores at 24 months (Table 7.30). The best model consisted of RPQ and pain, explaining 19% of the variance in anxiety (R^2 = .19, F = 10.17 [2, 88], p < .001). Of the two variables, RPQ provided the largest unique contribution (β = .32), however pain (β = .20) also provided a significant contribution. Although RPQ (4 groups) was included in Step 3 of the model and explained an additional 2% of the variance, it did not reach statistical significance (p = .126).

Depression factor. Three regression models were produced for predicting HADS depression scores at 3 months (Table D23 – Appendix D). RPQ was entered at Step 1, explaining 16% of the variance in depression. QOLI was added to the model in Step 2, the total variance explained by the model as a whole was 25%. The final model consisted of the predictors RPQ, QOLI, and pain, and explained 27% of the variance in depression scores at 3 months (R^2 = .27, F = 14.75 [3, 118], p < .001). Of the three variables, RPQ (β = .32) and QOLI (β = -.31) made significant contributions to the model and there was a trend for pain (β = .16) to provide a contribution (p = .056).

Two regression models were produced for predicting HADS depression scores at 6 months (Table 7.30). RPQ was entered at Step 1, explaining 13% of the variance in depression. QOLI was added to the model in Step 2, the total variance explained by the model as a whole was 20% (R^2 = .20, F = 13.70 [2, 111], p < .001). Of the two variables, RPQ made the largest unique contribution to the model (β = .32), however QOLI (β = -.26) also made a significant contribution.

One regression model was produced for predicting HADS depression scores at 12 months (Table 7.30), consisting of RPQ which explained 13% of the variance in depression (R^2 = .13, F = 14.98 [1, 102], p < .001). One regression model was produced for predicting HADS depression scores at 24 months (Table 7.30), consisting of RPQ which explained 12% of the variance in depression (R^2 = .12, F = 11.33 [1, 89], p = .001).

Psychomotor factor. Four regression models were produced for predicting HADS psychomotor scores at 3 months (Table D24 – Appendix D). The best model consisted of RPQ, QOLI, and pain (3 groups), explaining 31% of the variance in psychomotor (R^2 = .31, F = 18.04 [3, 118], p < .001). Of the three variables, RPQ made the largest unique contribution to the model (β = .38), however QOLI (β = -.24) and pain (3 groups; β = .21) also provided significant contributions. Although RPQ (4 groups) was included in the model in Step 4 and explained an additional 2% of the variance, it did not reach statistical significance (p = .144).

Two regression models were produced for predicting HADS psychomotor scores at 6 months (Table 7.30). RPQ was entered at Step 1, explaining 19% of the variance. QOLI was added to the model in Step 2, the total variance explained by the model as a whole was 25% (R^2 = .25, F = 18.22 [2, 111], p < .001). RPQ made the largest unique contribution to the model (β = .39), however QOLI (β = -.25) also provided a significant contribution.

Two regression models were produced for predicting HADS psychomotor scores at 12 months (Table D24 – Appendix D). The best model consisted of RPQ, explaining 15% of the variance in psychomotor (R^2 = .15, F = 17.89 [1, 102], p < .001). Although pain was included in the model in Step 2, and explained an additional 2% of the variance, it did not reach statistical significance (p = .112).

Three regression models were produced for predicting HADS psychomotor scores at 24 months (Table 7.30). Pain was entered at Step 1, explaining 10% of the variance. RPQ was added to the model in Step 2, the total variance explained by the model as a whole was 14%.

The final model consisted of the predictors pain, RPQ, and QOLI, and explained 17% of the variance in psychomotor scores at 24 months (R^2 = .17, F = 5.94 [3, 87], p = .001). Pain made the largest unique contribution to the model (β = .24). There was a trend for RPQ (β = .20) and QOLI (β = -.17) to provide contributions to the model (p = .065 and .098 respectively).

Table 7.30

Final Regression Models for Predicting HADS Factor Scores Using Initial Psychological/Physiological Variables (Excluding HADS Factors as Predictors)

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	RPQ	.08	.02	.40	5.01	< .001	*Y* = .71 + .08 (RPQ)
	Pain (3 groups)	.87	.31	.23	2.87	.005	+ .87 (Pain 3 groups)
	QOLI	-.34	.14	-.18	-2.36	.020	+ -.37 (QOLI)
	6-months						
	RPQ	.05	.02	.29	3.29	< .001	*Y* = 1.41 + .05 (RPQ)
	QOLI (4 groups)	-.45	.17	-.23	-2.69	.008	+ -.45 (QOLI 4 groups)
	Pain (3 groups)	.74	.30	.21	2.42	.017	+ .74 (Pain 3 groups)
	12-months						
	RPQ	.06	.02	.33	3.58	.001	*Y* = .28 + .06 (RPQ)
	Pain	.19	.07	.24	2.56	.012	+ .19 (Pain)
	24-months						
	RPQ	.06	.02	.32	3.08	.003	*Y* = .67 + .06 (RPQ)
	Pain	.17	.09	.20	1.92	.058	+ .17 (Pain)
	3-months						
Depression	RPQ	.04	.01	.32	3.79	< .001	*Y* = 1.20 + .04 (RPQ)
	QOLI	-.39	.10	-.31	-3.96	< .001	+ -.39 (QOLI)
	Pain	.10	.05	.16	1.93	.056	+ .10 (Pain)
	6-months						
	RPQ	.04	.01	.32	3.70	< .001	*Y* = 1.04 + .04 (RPQ)
	QOLI	-.27	.09	-.26	-3.02	.003	+ -.27 (QOLI)
	12-months						
	RPQ	.05	.01	.36	3.87	< .001	*Y* = .21 + .05 (RPQ)
	24-months						
	RPQ	.05	.01	.34	3.37	.001	*Y* = .33 + .05 (RPQ)

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Psychomotor	3-months						
	RPQ	.07	.01	.38	4.73	< .001	*Y* = 1.81 + .07 (RPQ)
	QOLI	-.41	.13	-.24	-3.10	.002	+ -.41 (QOLI)
	Pain (3 groups)	.73	.28	.21	2.56	.012	+ .73 (Pain 3 groups)
	6-months						
	RPQ	.07	.01	.39	4.68	< .001	*Y* = 2.35 + .07 (RPQ)
	QOLI	-.35	.12	-.25	-2.96	.004	+ -.35 (QOLI)
	12-months						
	RPQ	.07	.02	.39	4.23	< .001	*Y* = 1.30 + .07 (RPQ)
	24-months						
	Pain	.20	.09	.24	2.27	.026	*Y* = 2.12 + .20 (Pain) + .04 (RPQ)
	RPQ	.04	.02	.20	1.87	.065	
	QOLI	-.28	.17	-.17	1.67	.098	

7.3.13 Using 1-month Psychological/Physiological Variables to Predict HADS Scores

A series of stepwise multiple regression analyses were conducted to assess the ability of a number of psychological/physiological variables from the 1-month assessment to predict participants' HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI. The predictor variables are listed in Section 7.2.4. Sample sizes are displayed in 'Output – Study 3' (Appendix D on the CD) and varied according to the follow-up assessment and the variable measured (*N* = 161–271 participants). Each of the stepwise regression analyses is displayed in Tables D25, D26, D27, and D28 (Appendix D). The final prediction models and the accompanying regression equations are presented in Table 7.32.

Correlations. Means, standard deviations, and Pearson correlation coefficients for the regression analyses predicting HADS anxiety, depression, and psychomotor scores from 1-month psychological/physiological variables, are shown in Table 7.31. The 1-month HADS Anxiety factor showed large correlations with the Anxiety and Psychomotor factors at each

follow-up; a large correlation with the Depression factor at 3 months; and medium correlations with the Depression factor at 6, 12, and 24 months. The 1-month HADS Depression factor displayed large correlations with the Anxiety factor at 3, 6, and 12 months, and a medium correlation with the Anxiety factor at 24 months; large correlations with the Depression factor at each follow-up; large correlations with the Psychomotor factor at 3, 6, and 12 months, and a medium correlation with the Psychomotor factor at 24 months. The 1-month HADS Psychomotor factor showed large correlations with the Anxiety and Psychomotor factors at each follow-up; and large correlations with the Depression factor at 3, 6, and 24 months post-TBI.

Pain showed medium correlations with the Anxiety factor at 3, 12, and 24 months; a medium correlation with the Depression factor at 24 months; and medium correlations with the Psychomotor factor at 3, 12, and 24 months. RPQ showed large correlations with the Anxiety factor at 3 and 12 months, and medium correlations with the Anxiety factor at 6 and 24 months; medium correlations with the Depression factor at each follow-up; large correlations with the Psychomotor factor at 3 and 6 months, and medium correlations with the Psychomotor factor at 12 and 24 months. QOLI showed a medium negative correlation with the Anxiety factor at 3 months and medium negative correlations with the Depression and Psychomotor factors at each follow-up.

Table 7.31

Means, Standard Deviations and Correlations for 1-month Psychological/Physiological Predictor Variables and the HADS Factor Scores

Variable	*M*	*SD*	Anxiety Factor	Depression Factor	Psychomotor Factor	Pain	Fatigue	QOLI	RPQ
Anxiety									
3-months	2.39	2.29	.76***	.50***	.55***	.32***	.25***	-.33***	.53***
6-months	2.00	2.19	.72***	.50***	.57***	.28***	.19**	-.22***	.46***
12-months	2.01	2.22	.68***	.53***	.57***	.35***	.25***	-.25***	.52***
24-months	2.26	2.34	.62***	.41***	.52***	.40***	.13*	-.20**	.39***
Depression									
3-months	1.15	1.62	.51***	.69***	.58***	.28***	.18**	-.40***	.47***
6-months	1.11	1.65	.45***	.63***	.58***	.27***	.22***	-.34***	.47***
12-months	1.03	1.57	.41***	.55***	.26***	.25***	.21***	-.32***	.41***
24-months	1.19	1.83	.45***	.58***	.59***	.36***	.20***	-.38***	.41***
Psychomotor									
3-months	2.95	2.22	.63***	.58***	.72***	.32***	.30***	-.42***	.58***
6-months	2.62	2.10	.56***	.57***	.69***	.27***	.29***	-.31***	.54***
12-months	2.53	2.21	.52***	.52***	.67***	.33***	.22***	-.33***	.48***

Note. Pearson Correlation Coefficients are reported.
*$p < .05$. **$p < .01$. ***$p < .001$.

Anxiety factor. Two regression models were produced for predicting anxiety scores at 3 months (Table D25 – Appendix D). The best model (Table 7.32) consisted of the 1-month HADS Anxiety factor entered at Step 1, explaining 58% of the variance in anxiety ($R^2 = .58$, $F = 240.45$ [1, 171], $p < .001$). Although RPQ was added to the model in Step 2 and explained an additional 1% of variance, it did not reach statistical significance ($p = .112$).

Three regression models were produced for predicting anxiety scores at 6 months (Table D25 – Appendix D). The best model (Table 7.32) consisted of the 1-month HADS Anxiety and Psychomotor factors, explaining 54% of the variance ($R^2 = .54$, $F = 97.67$ [2, 168], $p < .001$). Of the two variables, the 1-month HADS Anxiety factor provided the largest

unique contribution to the model (β = .62), however the 1-month HADS Psychomotor factor also provided a significant contribution (β = .16). Although QOLI (4 groups) was included in the model in Step 3, it did not reach statistical significance (p = .091).

Three regression models were produced for predicting anxiety scores at 12 months (Table 7.32). The 1-month HADS Anxiety factor was entered at Step 1, explaining 46% of the variance in anxiety. The 1-month HADS Depression factor was added to the model in Step 2, the total variance explained by the model as a whole was 49%. The final model consisted of the predictors the 1-month HADS Anxiety and Depression factors, and pain (2 groups), and explained 51% of the variance in anxiety scores at 12 months. (R^2 = .51, F = 53.21 [3, 153], p < .001). Of the three variables, the 1-month HADS Anxiety factor made the largest unique contribution to the model (β = .52), with the 1-month HADS Depression factor (β = .22) and pain (2 groups) (β = .15) also providing statistically significant contributions.

Five regression models were produced for predicting HADS anxiety scores at 24 months (Table 7.32). The 1-month HADS Anxiety factor was entered at Step 1, explaining 39% of the variance in anxiety scores. Pain was added to the model in Step 2, the total variance explained by the model as a whole was 43%. In Step 3, fatigue (2 groups) was added to the model, increasing the total variance explained to 44%. The 1-month HADS Psychomotor factor was added to the model in Step 4, the total variance explained by the model as a whole was 45%. The final model consisted of the predictors 1-month HADS Anxiety factor, pain, fatigue (2 groups), the 1-month HADS Psychomotor factor, and QOLI, and explained 47% of the variance in anxiety scores at 24 months (R^2 = .47, F = 23.29 [5, 129], p < .001). Of the five variables, the 1-month HADS Anxiety factor made the largest unique contribution to the model (β = .49). However, pain (β = .22), fatigue (2 groups) (β = -.14), the 1-month HADS Psychomotor factor (β = .25), and QOLI (β = .18) each provided a statistically significant contribution.

Depression factor. Three regression models were produced for predicting HADS depression scores at 3 months (Table D27 – Appendix D). The best model (Table 7.32) consisted of the 1-month HADS Depression and Anxiety factors, explaining 49% of the variance in depression ($R^2 = .49$, $F = 81.30$ [2, 170], $p < .001$). Of the two variables, the 1-month HADS Depression factor made the largest unique contribution to the model (β = .59), however the 1-month HADS Anxiety factor also provided a significant contribution (β = .16). Although pain (3 groups) was included in the model in Step 3, it did not reach statistical significance ($p = .120$).

Three models were produced for predicting HADS depression scores at 6 months (Table 7.32). The 1-month HADS Depression factor was entered at Step 1, explaining 40% of the variance in depression scores. The 1-month HADS Psychomotor factor was added to the model at Step 2, explaining 42% of the variance in depression scores. The final model consisted of the predictors the 1-month HADS Depression and Psychomotor factors, and pain (3 groups), and explained 44% of the variance in psychomotor scores ($R^2 = .44$, $F = 43.03$ [3, 167], $p < .001$). Of the variables, the 1-month HADS Depression factor made the largest unique contribution to the model (β = .55). However, the 1-month HADS Psychomotor factor (β = .20) and pain (3 groups) (β = .12) also provided a statistically significant contribution.

Two models were produced for predicting HADS depression scores at 12 months (Table 7.32). The 1-month HADS Psychomotor factor was entered at Step 1, explaining 31% of the variance in depression scores. The 1-month HADS Depression factor was added to the model in Step 2, the total variance explained by the model as a whole was 35% ($R^2 = .35$, $F = 41.19$ [2, 154], $p < .001$). Both variables made a statistically significant contribution to the model.

Three models were produced for predicting HADS depression scores at 24 months (Table 7.32). The 1-month HADS Psychomotor factor was entered at Step 1, explaining 34%

of the variance in depression scores. The 1-month HADS Depression factor was added to the model in Step 2, the total variance explained by the model as a whole was 39%. The final model consisted of the predictors the 1-month HADS Psychomotor and Depression factors, and pain (2 groups), and explained 42% of the variance in depression scores at 24 months (R^2 = .42, F = 31.27 [3, 131], p < .001). The 1-month HADS Psychomotor (β = .31) and Depression (β = .31) factors made the largest unique contributions to the model, however pain (2 groups; β = .18) also provided a statistically significant contribution.

Psychomotor factor. Three models were produced for predicting HADS scores at 3 months (Table 7.32). The 1-month HADS Psychomotor factor was entered at Step 1, explaining 52% of the variance in psychomotor scores. The 1-month HADS Anxiety factor was added to the model in Step 2, explaining 57% of the variance in psychomotor scores. The final model consisted of the predictors the 1-month HADS Psychomotor and Anxiety factors, and RPQ (4 groups), and explained 58% of the variance in psychomotor scores at 3 months (R^2 = .58, F = 76.93 [3, 169], p < .001). The 1-month HADS Psychomotor factor (β = .48) made the largest unique contribution to the model. However, the 1-month HADS Anxiety factor (β = .25) and RPQ (4 groups) (β = .14) also provided a statistically significant contribution to the model.

Three models were produced for predicting HADS psychomotor scores at 6 months (Table 7.32). The 1-month HADS Psychomotor factor was entered at Step 1, explaining 47% of the variance in psychomotor scores. The 1-month HADS Anxiety factor was added to the model in Step 2, the total variance explained by the model as a whole was 49%. The final model consisted of the predictors the 1-month HADS Psychomotor and Anxiety factors, and RPQ, and explained 50% of the variance in psychomotor scores at 6 months (R^2 = .50, F = 56.04 [3, 169], p < .001). The 1-month HADS Psychomotor factor provided the largest

unique contribution to the model (β = .52). There were trends for the 1-month HADS Anxiety factor (β = .18) and RPQ (β = .18) to provide a contribution (p = .80 and .85, respectively).

Three models were produced for predicting HADS psychomotor scores at 12 months (Table D28 – Appendix D). The best model (Table 7.32) consisted of the 1-month HADS Psychomotor factor and pain (2 groups), explaining 47% of the variance in psychomotor (R^2 = .47, F = 67.53 [2, 154], p < .001). Of the two variables, the 1-month HADS Psychomotor factor provided the largest unique contribution to the model (β = .63), however pain (2 groups) also provided a significant contribution (β = .15). Although the 1-month HADS Anxiety factor was included in the model in Step 3, it did not reach statistical significance (p = .147).

Three models were produced for predicting HADS psychomotor scores at 24-months (Table D28 – Appendix D). The best model (Table 7.32) consisted of the 1-month HADS Psychomotor factor and pain (3 groups), explaining 44% of the variance in psychomotor (R^2 = .44, F = 51.57 [2, 132], p < .001). Of the two variables, the 1-month HADS Psychomotor factor provided the largest unique contribution to the model (β = .53), however, pain (3 groups) also provided a significant contribution (β = .23). Although the 1-month HADS Anxiety factor was included in the model in Step 3, it did not reach statistical significance (p = .131).

Table 7.32

Final Regression Models for Predicting HADS Factor Scores Using 1-Month Complete Psychological/Physiological Variables

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	Anxiety Factor	.78	.05	.76	15.51	< .001	*Y* = .40 + .78 (Anxiety Factor)
	6-months						
	Anxiety Factor	.59	.07	.62	8.82	< .001	Y = .06 + .59 (Anxiety Factor)
	Psychomotor Factor	.15	.06	.16	2.36	.019	+ .15 (Psychomotor Factor)
	12-months						
	Anxiety Factor	.52	.07	.52	7.27	< .001	*Y* = -.73 + .52 (Anxiety Factor)
	Depression Factor	.28	.09	.22	3.11	.002	+ .28 (Depression Factor)
	Pain (2 groups)	.92	.37	.15	2.50	.013	+ .92 (Pain 2 groups)
	24-months						
	Anxiety Factor	.51	.09	.49	5.60	.001	*Y* = .045 + .51 (Anxiety Factor)
	Pain	.20	.07	.22	3.07	.003	+ .20 (Pain)
	Fatigue (2 groups)	-.68	.34	-.14	-2.02	.046	+ -.68 (Fatigue 2 groups)
	Psychomotor Factor	.24	.09	.25	2.62	.010	+ .24 (Psychomotor Factor)
	QOLI	.24	.10	.18	2.36	.020	+ .24 (QOLI)
Depression	3-months						
	Depression Factor	.57	.07	.59	8.75	< .001	*Y* = .09 + .57 (Depression Factor)
	Anxiety Factor	.12	.05	.16	2.37	.019	+ .12 (Anxiety Factor)
	6-months						
	Depression Factor	.45	.09	.45	5.17	< .001	*Y* = -.40 + .45 (Depression Factor)
	Psychomotor Factor	.14	.06	.20	2.28	.024	+ .14 (Psychomotor Factor)
	Pain (3 groups)	.36	.18	.12	2.00	.047	+ .36 (Pain 3 groups)

HADS	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Depression	12-months						
	Psychomotor Factor	.21	.06	.33	3.43	.001	*Y* = -.04 + .21 (Psychomotor Factor)
	Depression Factor	.28	.09	.31	3.17	.002	+ .28 (Depression Factor)
	24-months						
	Psychomotor Factor	.23	.08	.31	3.04	.003	*Y* = -1.06 + .23 (Psychomotor Factor)
	Depression Factor	.33	.10	.31	3.15	.002	+ .33 (Depression Factor)
	Pain (2 groups)	.91	.37	.18	2.51	.013	+ .91 (Pain 2 groups)
Psychomotor	3-months						
	Psychomotor Factor	.44	.07	.48	6.69	< .001	*Y* = .32 + .44 (Psychomotor Factor)
	Anxiety Factor	.24	.07	.25	3.62	< .001	+ .24 (Anxiety Factor)
	RPQ (4 groups)	.27	.13	.14	2.04	.043	+ .27 (RPQ 4 groups)
	6-months						
	Psychomotor Factor	.45	.07	.52	6.58	< .001	*Y* = .54 + .45 (Psychomotor Factor)
	Anxiety Factor	.13	.07	.14	1.76	.080	+ .13 (Anxiety Factor)
	RPQ	.02	.01	.13	1.73	.085	+ .02 (RPQ)
	12-months						
	Psychomotor Factor	.57	.05	.63	10.51	< .001	*Y* = -.43 + .57 (Psychomotor Factor)
	Pain (2 groups)	.96	.38	.15	2.54	.012	+ .96 (Pain 2 groups)
	24-months						
	Psychomotor Factor	.52	.07	.53	7.45	< .001	*Y* = -.19 + .52 (Psychomotor Factor)
	Pain (3 groups)	.91	.29	.23	3.17	.002	+ .91 (Pain 3 groups)

Excluding the HADS factors as predictors. A further series of stepwise multiple regression analyses were conducted to assess the ability of the psychological/physiological variables measured at 1-month, to predict participants' HADS factor scores at the later follow-up assessments. These analyses involved excluding the HADS factors as predictor variables. Sample sizes varied according to the follow-up assessment and the variable measured (N = 161–271 participants; see 'Output – Study 3' in Appendix D on the CD). Each of the stepwise regression analyses is displayed in Table D29, D30, and D31 (Appendix D). The final prediction models and the accompanying regression equations are presented in Table 7.33.

Anxiety factor. Five regression models were produced for predicting HADS anxiety scores at 3 months (Table D29 – Appendix D). The best model (Table 7.33) consisted of RPQ and QOLI, explaining 30% of the variance in anxiety (R^2 = .30, F = 36.79 [2, 170], p < .001). This model was chosen as being superior due to different variants of the same variables featuring in Steps 3 to 5 (QOLI 4 groups, fatigue 3 groups, fatigue). Of the two variables included in the model, RPQ provided the largest unique contribution (β = .47), however, QOLI also provided a significant contribution (β = -.16).

One regression model was produced for predicting HADS anxiety scores at 6 months (Table 7.33), consisting of RPQ which explained 21% of the variance in anxiety (R^2 = .21, F = 44.68 [1, 169], p < .001).

Two regression models were produced for predicting HADS anxiety scores at 12 months (Table 7.33). RPQ was entered at Step 1, explaining 27% of the variance in anxiety. The final model consisted of the predictors RPQ and pain (2 groups), and explained 28% of the variance in anxiety scores at 12 months (R^2 = .28, F = 30.45 [2, 154], p < .001). Of the two variables, RPQ made the largest unique contribution to the model (β = .46). However,

there was a trend (p = .058) for pain (2 groups; β = .14) to provide a statistically significant contribution.

Two regression models were produced for predicting HADS anxiety scores at 24 months (Table 7.33). Pain was entered at Step 1, explaining 16% of the variance in anxiety. The final model consisted of the predictors pain and RPQ, and explained 21% of the variance in anxiety scores at 24 months (R^2 = .21, F = 17.01 [2, 132], p < .001). Both pain (β = .27) and RPQ (β = .25) made a significant contribution to the model (p < .01).

Depression factor. Two regression models were produced for predicting HADS depression scores at 3 months (Table D30 – Appendix D). RPQ was entered at Step 1, explaining 26% of the variance in depression. The final model consisted of the predictors RPQ and QOLI, and explained 29% of the variance in depression scores at 3 months (R^2 = .29, F = 34.19 [2, 170], p < .001). Of the two variables, RPQ (β = .38) made the largest unique contribution to the model, however QOLI (β = -.27) also provided a statistically significant contribution.

Two regression models were produced for predicting HADS depression scores at 6 months (Table 7.33). RPQ was entered at Step 1, explaining 22% of the variance in depression. The final model consisted of the predictors RPQ and QOLI, and explained 25% of the variance in depression scores at 6 months (R^2 = .25, F = 28.62 [2, 168], p < .001). Of the two variables, RPQ (β = .40) made the largest unique contribution to the model, however QOLI (β = -.20) also provided a statistically significant contribution.

Two regression models were produced for predicting HADS depression scores at 12 months (Table 7.33). RPQ was entered at Step 1, explaining 17% of the variance in depression. The final model consisted of the predictors RPQ and QOLI, and explained 19% of the variance in depression scores at 12 months (R^2 = .19, F = 18.46 [2, 154], p < .001). Of

the two variables, RPQ (β = .34) made the largest unique contribution to the model, however QOLI (β = -.17) also provided a statistically significant contribution.

Three regression models were produced for predicting HADS depression scores at 24 months (Table 7.33). RPQ was entered at Step 1, explaining 17% of the variance in depression. Pain (3 groups) was added to the model in Step 2, the total variance explained by the model as a whole was 22%. The final model consisted of the predictors RPQ, pain (3 groups), and QOLI, and explained 25% of the variance in depression scores at 24 months (R^2 = .25, F = 14.23 [3, 131], p < .001). Each of the three variables provided a significant contribution to the model (p < .05).

Psychomotor factor. Four regression models were produced for predicting HADS psychomotor scores at 3 months (Table D31 – Appendix D). The best regression model (Table 7.33) consisted of RPQ and QOLI, explaining 39% of the variance in psychomotor (R^2 = .39, F = 53.52 [2, 170], p < .001). Of the two variables, RPQ provided the largest unique contribution to the model (β = .50), however, QOLI also provided a significant contribution (β = -.23). Although pain (3 groups) and fatigue (3 groups) were included in the model in Steps 3 and 4, they did not reach statistical significance (p = .132 and .133 respectively).

Two regression models were produced for predicting HADS psychomotor scores at 6 months (Table 7.33). RPQ was entered at Step 1, explaining 29% of the variance in psychomotor. The final model consisted of the predictors RPQ and QOLI, and explained 31% of the variance in psychomotor scores at 6 months (R^2 = .31, F = 37.14 [2, 168], p < .001). Of the two variables, RPQ (β = .49) made the largest unique contribution to the model. There was a trend for QOLI (β = -.13) to provide a statistically significant contribution (p = .053).

Three regression models were produced for predicting HADS psychomotor scores at 12 months (Table 7.33). RPQ was entered at Step 1, explaining 23% of the variance in psychomotor scores. QOLI was added to the model in Step 2, explaining 25% of the variance

in psychomotor scores. The final model consisted of the predictors RPQ, QOLI, and pain (2 groups), and explained 27% of the variance in psychomotor symptoms at 12 months (R^2 = .27, F = 18.50 [3, 153], p < .001). Of the three variables, RPQ (β = .36) made the largest unique contribution to the model, with QOLI (β = -.16) also providing a statistically significant contribution. There was a trend for pain (2 groups) (β = .13) to make a statistically significant contribution to the model (p = .077).

Two regression models were produced for predicting HADS psychomotor scores at 24 months (Table 7.33). Pain (3 groups) was entered at Step 1, explaining 20% of the variance in psychomotor symptoms. The final model consisted of the predictors pain (3 groups) and RPQ, and explained 26% of the variance in psychomotor symptoms at 24 months (R^2 = .26, F = 23.48 [2, 132], p < .001). Both variables made a statistically significant contribution to the model (p < .001).

Table 7.33

Final Regression Models for Predicting HADS Factor Scores Using 1-Month Psychological/Physiological Variables (Excluding HADS Factors as Predictors)

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Anxiety	3-months						
	RPQ	.09	.01	.47	6.89	< .001	*Y* = 1.56 + .09 (RPQ)
	QOLI	-.22	.09	-.16	-2.35	.020	+ -.22 (QOLI)
	6-months						
	RPQ	.08	.01	.46	6.68	< .001	*Y* = .75 + .08 (RPQ)
	12-months						
	RPQ	.09	.01	.46	6.30	< .001	*Y* = -.28 + .09 (RPQ)
	Pain (2 groups)	.89	.46	.14	1.91	.058	+ .89 (Pain 2 groups)
	24-months						
	Pain	.25	.08	.27	2.98	.003	*Y* = .96 + .25 (Pain)
	RPQ	.05	.02	.25	2.70	.008	+ .05 (RPQ)
Depression	3-months						
	RPQ	.05	.01	.38	5.49	< .001	*Y* = .99 + .05 (RPQ) + -.25 (QOLI)
	QOLI	-.25	.07	-.27	-3.85	< .001	
	6-months						
	RPQ	.05	.01	.40	5.63	< .001	*Y* = .76 + .05 (RPQ) + -.20 (QOLI)
	QOLI	-.20	.07	-.20	-2.24	.007	
	12-months						
	RPQ	.04	.01	.34	4.24	< .001	*Y* = .74 + .04 (RPQ) + -.16 (QOLI)
	QOLI	-.16	.07	-.17	-2.19	.030	
	24-months						
	RPQ	.03	.01	.22	2.33	.021	*Y* = .31 + .03 (RPQ)
	Pain (3 groups)	.66	.28	.21	2.36	.020	+ .66 (Pain 3 groups)
	QOLI	-.21	.09	-.20	-2.27	.025	+ -.21 (QOLI)

HADS Factor	Model/Variable	*B*	*SE B*	β	*t*	*p*	Equation
Psychomotor	3-months						
	RPQ	.09	.01	.50	7.79	< .001	*Y* = 2.29 + .09 (RPQ)
	QOLI	-.30	.08	-.23	-3.63	< .001	+ -.30 (QOLI)
	6-months						
	RPQ	.08	.01	.49	7.16	< .001	*Y* = 1.74 + .08 (RPQ)
	QOLI	-.17	.09	-.13	-1.95	.053	+ -.17 (QOLI)
	12-months						
	RPQ	.07	.02	.36	4.47	< .001	*Y* = 1.06 + .07 (RPQ)
	QOLI	-.21	.10	-.16	-2.09	.038	+ -.21 (QOLI)
	Pain (2 groups)	.83	.47	.13	1.78	.077	+ .83 (Pain 2 groups)
	24-months						
	Pain (3 groups)	1.23	.34	.31	3.59	< .001	*Y* = .22 + 1.23 (Pain 3 groups)
	RPQ	.05	.02	.28	3.26	.001	+ .05 (RPQ)

7.4. Study 3 - Discussion

Study 3 aimed to examine differences in TBI participants' scores on the HADS based on the psychological/physiological consequences of head injury variables: pain, fatigue, quality of life, and post-concussion symptoms. Data for this study was collected at six follow-up assessments over 2 years after participants sustained a TBI. In order to provide a detailed exploration of the relationship between participants' mood outcome and the psychological/physiological variables, both cross-sectional sample and longitudinal sample analyses were performed on the data, as well as correlations and multiple regression analyses.

7.4.1 Descriptive Statistics

The descriptive statistics in Study 3 tended to be consistent across both samples, with the main difference indicating higher levels of post-concussion symptoms (RPQ score – moderate range) in the cross-sectional sample, compared with longitudinal sample (RPQ

score – mild range). In both the cross-sectional and longitudinal samples, the majority of participants reported low levels of pain (approximately 50%) and medium levels of fatigue (approximately 50%). Participants tended to less frequently report high pain and fatigue levels (approximately 10% of the participants). The mean SQOL scores indicated participants on average reported high SQOL at both pre-injury and the initial follow-up.

7.4.2 Mood Recovery

In the longitudinal sample analyses, participants showed a significant reduction in anxiety, depression, and psychomotor HADS scores over time, with fewer symptoms generally reported at 2 years following injury. However, the cross-sectional sample analyses showed quite a different pattern of recovery. Whilst displaying early recovery on the HADS factors between the initial follow-up and 6 months post-injury, participants HADS scores tended to either plateau from 6 months to 24 months, or increase over these later time periods.

Participants displayed different patterns of recovery, depending on the HADS factor investigated—providing strong support for the Skilbeck et al. (2011) HADS three-factor model. Participants HADS depression and psychomotor scores were generally higher than the mean scores provided by Dunbar (et al. 2001) normative sample, at each follow-up. However, there was little difference across the follow-ups between participants' anxiety scores and those provided by Dunbar (et al. 2001).

7.4.3 Pain

The hypothesis, *higher pain ratings will relate to HADS factor scores* was well supported results. Cross-sectional analyses were performed to examine participants' mood at each follow-up, using their initial pain scores. Participants with high initial pain reported significantly higher anxiety, depression, and psychomotor scores than participants with low initial pain at each time period post-TBI. Compared with participants with medium initial

pain, participants with high initial pain also tended to show significantly higher anxiety, depression, and psychomotor scores across the follow-ups. Participants with medium initial pain reported significantly higher anxiety, depression, and psychomotor symptoms than participants with low initial pain at each follow-up. These are noteworthy findings given the analyses were performed over a 2-year period, with participants' pain level measured at the initial follow-up. The greatest effect sizes tended to be found at the earlier follow-ups, however, substantial effect sizes were also found at the later follow-ups.

Additional cross-sectional analyses were performed to examine participants' mood post-TBI, using their pain scores measured at each individual follow-up. Participants with high pain levels reported significantly higher anxiety, depression, and psychomotor scores than participants with low pain levels at each follow-up post-TBI. Participants with high pain levels showed significantly higher anxiety, depression, and psychomotor scores than participants with medium pain levels group, at most of the follow-ups. At each follow-up, participants with medium pain levels reported significantly higher anxiety scores than participants with low pain levels. The size of the effects ranged from medium to large, indicating strong relationships between the HADS factors and concurrent pain ratings.

Overall, the results indicate strong effect sizes for TBI patients with greater levels of pain to experience higher levels of mood problems over 2 years following injury. This supports previous research (Bryant, Marosszeky, & Crooks, 2000; Hoffman et al., 2007) that has found greater pain is associated with increased mood difficulties after TBI, such as depression and PTSD symptoms. However, these previous studies tended to include only moderate and severe TBI patients. The present research as a population study suggests that mild TBI patients with higher levels of pain also experience greater mood disturbance.

Pain can be considered a stressor that indicates harm to the body (Caudill, 2002). It has been found to increase an individual's affectivity and lower quality of life (Macdonald &

Kingsbury, 2006; Rice, 1998). Studies have found that one's self-efficacy can affect their perception and tolerance of pain (Bandura, O'Leary, Taylor, Gauthier, & Gossard, 1987; Lackner, Carosella, & Feuerstein, 1996). This suggests that a person's perception of their ability to cope with pain can affect their pain experience (Caudill, 2002). TBI patients with higher levels of pain may perceive they have less ability to cope with the threats that pain poses, such as potentially interfering with their physical, social, academic, and occupational functioning, and their recovery from TBI (Caudill, 2002). A cognitive model would suggest that these perceptions (based upon a person's beliefs and expectations) could lead to symptoms of the fight-or-flight response and increased mood disturbance post-TBI (Caudill, 2002; Rice, 1998).

7.4.4 Fatigue

The hypothesis, *higher fatigue ratings will relate to HADS factor scores,* was well supported by the results. Cross-sectional sample analyses were performed to examine participants' mood at each follow-up, using their initial fatigue scores. Participants with high initial fatigue reported significantly higher anxiety, depression, and psychomotor scores than participants with low initial fatigue at each follow-up post-TBI. Compared with participants with medium initial fatigue, participants with high initial fatigue showed significantly higher depression scores at each follow-up, and significantly higher anxiety and psychomotor scores at all follow-ups except at 6 months. Participants with medium initial fatigue reported significantly higher anxiety, depression, and psychomotor symptoms than participants with low initial fatigue at each follow-up. The greatest effect sizes tended to be found at the earlier follow-ups, however, substantial effect sizes were also found at the later follow-ups. These results are noteworthy, given the long period of follow-up investigated.

Additional cross-sectional sample analyses were performed to examine participants' mood post-TBI, using their fatigue scores at each follow-up. These analyses also provided

strong support for the hypothesis. Participants with high fatigue levels showed significantly higher anxiety, depression, and psychomotor scores than participants with low fatigue levels at each follow-up post-TBI. Participants with high fatigue levels showed significantly higher depression scores than participants with low fatigue levels at each follow-up post-TBI. Participants with medium fatigue levels showed significantly higher anxiety, depression, and psychomotor scores than participants with low fatigue levels at each follow-up. For differences in participants HADS scores based on their fatigue levels, medium sized effects were found at each follow-up.

Overall, the results suggest strong effects for patients with greater levels of fatigue to experience higher levels of mood problems over 2 years following injury. These findings support research that has found higher levels of mood disturbance after TBI in patients with fatigue (Ouellet & Moirin, 2006; Ziino & Ponsford 2005), including a recent study by Ponsford et al. (2012) that found HADS anxiety and depression subscale scores correlated significantly with participants' fatigue scores and significantly predicted participants' scores on the Fatigue Severity Scale. Fatigue is a common symptom of depression (Silver et al., 2005), and this may account for the present findings in regard to the Depression factor. However, fatigue is also a frequent and important post-concussion symptom that impairs a person's ability to perform day-to-day tasks that were previously automatic. If a person has difficulty coping with the impairments caused by fatigue, this may lead to mood disturbance such as anxiety and depression.

7.4.5 Relationship Between Initial Pain and Fatigue

To determine whether there is a relationship between participants' initial pain and fatigue scores in regards to their influence on mood, two-way between-subjects ANOVAs were conducted at each follow-up. The results indicated both initial pain and fatigue scores independently had an effect on mood post-TBI. Additionally, significant interactions were

found between initial pain and initial fatigue. These interactions indicated that participants with low initial fatigue consistently experienced the lowest mood scores, regardless of whether they also experienced low or high pain. The interactions also indicated that at 3 months and 12 months, participants with both high pain & high fatigue had greater anxiety, depression, and psychomotor scores compared with the other participants. This is an interesting finding and it is uncertain as to why these results occurred at these particular time periods.

7.4.6 Quality of Life

The hypothesis, *TBI patients who score lower on the QOLI will have higher HADS factor scores*, was well supported by the results. Cross-sectional sample analyses were performed to examine participants' mood based on their QOLI scores at the initial, 3-month, 6-month, 12-month, and 24-month follow-up assessments. There were large effects for participants with low SQOL to show significantly higher anxiety, depression and psychomotor scores than participants with high SQOL at each follow-up.

Additional cross-sectional sample analyses were performed to examine participants' mood at each follow-up, using their estimated pre-injury QOLI scores. These analyses indicated participants with low pre-injury QOLI tended to show significantly higher HADS scores than participants with high pre-injury QOLI. The greatest effects were found for differences in anxiety scores at 6 months, and differences in depression and psychomotor scores at 3 months and 6 months.

Overall, the results indicate strong effects for TBI patients with lower levels of SQOL to experience higher levels of mood problems over 2 years following injury. These results are supported by studies such as Underhill et al. (2003) that found depressed TBI participants rated significantly poorer life satisfaction scores and Thomas (2008) that found moderate statistically significant correlations between the QOLI total score and the HADS Anxiety,

Depression, and Psychomotor factors across 1 year post-TBI. It makes sense that patients with mood problems would express greater dissatisfaction with life, due to the many barriers the symptoms of anxiety and depression can place on one's life. However, it is important to recognise that it is not necessarily ones mood that leads to poor quality of life - the findings of the present study indicate TBI patients with lower pre-injury QOLI showed vulnerability to experiencing greater mood disturbance after injury.

7.4.7 Post-concussion Symptoms

The hypothesis, *TBI patients with higher scores on the RPQ will have higher HADS factor scores*, was well supported by the results. Cross-sectional sample analyses were performed to examine participants' mood based on their RPQ scores at the initial follow-up assessment. There were large effects for participants with severe levels of post-concussion symptoms to show significantly higher anxiety, depression, and psychomotor scores than participants with minimal, mild, and moderate post-concussion symptoms, at each follow-up. Participants with moderate levels of post-concussion symptoms tended to show significantly higher anxiety, depression, and psychomotor scores than participants with minimal and mild post-concussion symptoms, across the follow-ups.

Further cross-sectional sample analyses were performed to explore participants' mood based on their RPQ scores measured at each follow-up assessment. There were large effects for participants with severe levels of post-concussion symptoms to show significantly higher anxiety, depression, and psychomotor scores than participants with minimal, mild, and moderate post-concussion symptoms, at each follow-up. Participants with moderate levels of post-concussion symptoms showed significantly higher anxiety, depression, and psychomotor scores than participants with minimal levels of post-concussion symptoms, at each follow-up. Participants with moderate levels of post-concussion symptoms showed significantly higher depression and psychomotor scores than participants with mild levels of post-concussion

symptoms at each of the follow-ups, and significantly higher anxiety scores than participants with mild levels of post-concussion symptoms at 3 months, 6 months, 12 months, and 24 months post-TBI. Participants with mild levels of post-concussion symptoms showed significantly higher psychomotor scores than participants with minimal levels of post-concussion symptoms at each follow-up, and significantly higher anxiety and depression scores than participants with minimal levels of post-concussion symptoms at 1 month, 3 months, 6 months, 12 months, and 24 months post-TBI.

Overall there were strong findings indicating TBI participants with more severe levels of post-concussion symptoms experienced higher levels of mood problems over 2 years following injury. A relationship between the RPQ and the HADS would be expected given the RPQ includes items measuring emotion (poor sleep, irritability, depression, frustration, and restlessness). However, the sheer size of the effects found suggests that the other non-psychological domains of the RPQ (e.g. Physical, Cognitive, and Visual; Cannan, Skilbeck, & Slatyer, 2007) may also have a relationship with the HADS. The present results support previous studies that have found a relationship between higher levels of mood problems and severity of post-concussion symptoms post-TBI (Rapoport et al. 2003; Smith-Seemileer et al. 2003). Greater mood problems may result from difficulties adjusting to life after head injury due to disabling post-concussion symptoms that can affect a range of functioning in areas such as employment and the psychosocial domain (King et al. 1995). However, it is important to recognise the increased sensitivity to physical symptoms patients with anxiety and depression may experience, so the present results may be explained by participants over-reporting/more fixated on, physical symptoms (APA, 2013).

7.4.8 Longitudinal Sample

The longitudinal sample analyses provided strong support for the hypotheses. Moderate to large effect sizes were found for participants with low levels of pain to have significantly

lower anxiety, depression, and psychomotor scores than participants with medium levels of pain. Participants with low levels of pain also showed significantly lower psychomotor scores than participants with high pain levels, and a trend for significantly lower anxiety and depression scores than participants with high pain levels. Participants with low fatigue showed significantly lower depression and psychomotor scores than participants with moderate fatigue, with the greatest effect found for differences in depression scores.

There were large effects sizes for participants with low SQOL to score significantly higher on the HADS factors compared with participants with high SQOL. Very large effect sizes were found for participants in the severe RPQ group to score significantly higher on the HADS factors than participants in the minimal, mild, and moderate RPQ groups. There was a trend for the participants in the moderate RPQ group to show higher psychomotor scores than the minimal RPQ group.

7.4.9 Normative Data

Visual inspection of the mean HADS scores indicated some large differences when compared with the mean HADS scores reported by Dunbar et al. (2000) normative sample. Participants with medium and high pain or fatigue tended to report higher HADS scores than the normative data, with very large differences between participants with high pain or fatigue and the normative data. Participants with low SQOL reported much higher mean HADS scores than the normative data. Participants with moderate and severe levels of post-concussion symptoms showed higher HADS scores than the normative data.

Although the findings indicate some large differences between the present study and the normative sample in terms of the mean HADS scores reported, these findings should be interpreted with caution due to differences in the age ranges of the samples (see Chapter 9 – Section 9.5).

7.4.10 Correlations

As expected, the results of the correlational analyses indicated there were strong relationships between each of the HADS Anxiety, Depression, and Psychomotor factors. At each follow-up (with the exception of 1 month), there were strong inverse relationships between participants' RPQ scores and each of the HADS factors, suggesting participants with higher HADS scores tend to report lower SQOL. Additionally, medium to large correlations were found between participants' initial RPQ score and their HADS anxiety, depression, and psychomotor scores at each follow-up.

At each follow-up (with the exception of the initial follow-up), there were medium to strong negative correlations between participants' QOLI and RPQ scores, suggesting that participants reporting more severe levels of post-concussion symptoms tended to report lower SQOL. It is likely the small correlation between participants' QOLI and RPQ scores at the initial follow-up was because the QOLI scores at this follow-up measured participants' pre-injury SQOL.

The hypotheses for pain and fatigue were supported with medium positive relationships found between these variables and each of the HADS factors. Pain consistently showed medium correlations with the HADS factors across the follow-ups. Fatigue showed medium correlations with the HADS factors at the 3-month follow-up and smaller correlations at the later follow-up assessments. There were also medium positive correlations between pain and fatigue at all follow-up assessments with the exception of 1-month.

7.4.11 Multiple Regression

Using initial follow-up psychological/physiological variables to predict HADS scores. Regression models for the psychological/physiological variables tended to account for a substantial proportion of the variance in participants' HADS scores (ranging from 12–34%). The best models were found for predicting anxiety and psychomotor scores at 3

months, with post-concussion symptoms, pain, and SQOL accounting for 34% of the variance in anxiety; and post-concussion symptoms, SQOL, and pain, accounting for 33% of the variance in psychomotor scores.

Variables that provided statistically significant (or a trend for) unique contributions to the regression models included post-concussion symptoms, pain, and SQOL.

Using 1-month follow-up psychological/physiological variables to predict HADS scores. Regression models for the psychological/physiological variables tended to account for a substantial proportion of the variance in participants' HADS scores (ranging from 19–40%). The best models were found for predicting anxiety and psychomotor scores at 3 months, with post-concussion symptoms, SQOL, and fatigue accounting for 37% of the variance in anxiety scores; and post-concussion symptoms, SQOL, pain, and fatigue accounting for 40% of the variance in psychomotor scores.

Variables that tended to provide statistically significant (or a trend for) unique contributions included post-concussion symptoms, pain, and SQOL

Using initial follow-up psychological/physiological variables to predict HADS scores including HADS factors as predictors. Regression models for the psychological/physiological variables tended to account for a substantial proportion of the variance explained (19–53%). The best models were found for predicting anxiety, depression, and psychomotor scores at 3 months, with anxiety, SQOL, post-concussion symptoms, and pain explaining 53% of the variance in anxiety scores; depression, anxiety and SQOL, explaining 46% of the variance in depression scores; and psychomotor, anxiety, SQOL, pain, and post-concussion symptoms explaining 46% of the variance in psychomotor scores.

Variables that tended to provide statistically significant (or a trend for) unique contributions included post-concussion symptoms, pain, and SQOL

Using 1-month follow-up psychological/physiological variables to predict HADS scores including HADS factors as predictors. Regression models for the psychological/physiological variables tended to account for a substantial proportion of the variance explained (19–58%). The best models were found for predicting anxiety and psychomotor scores at 3 months, with anxiety and post-concussion symptoms accounting for 58% of the variance in anxiety scores; and psychomotor, anxiety, and post-concussion symptoms, accounting for 58% of the variance in psychomotor scores.

Variables that tended to provide statistically significant (or a trend for) unique contributions included the HADS Anxiety, Depression and Psychomotor factors, post-concussion symptoms, pain, and SQOL.

Best versions of measures. There were a number of different ways of categorising the psychological/physiological variables included in the regression analyses. Overall, the 3 group pain and fatigue variables featured more consistently and tended to provide greater contributions than the other pain and fatigue variables (total score, 2 groups). The total score RPQ and QOLI variables featured more consistently and tended to provide greater contributions than the other RPQ and QOLI variables.

7.4.12 Limitations

The limitations discussed in Study 1 (Chapter 5 – Section 5.4.13) also apply to the present study. However, it should also be acknowledged that the variables in Study 3 were each measured using self-rating scales. This shared approach to measurement, whilst unavoidable, can spuriously inflate the strength of associations in studies (Field, 2005). Additionally, it is likely that the variables significantly co-varied in terms of their relationship with participants' HADS scores, in a mutually enhancing and bi-directional manner (Malec et al., 2010), which may be a topic for future research to examine.

7.5 Summary of Findings From Study 3

Study 3 examined the influence of the psychological/physiological consequences of head injury on the emotional outcome of TBI patients over a 2-year post-injury period. The findings indicated participants in the longitudinal sample analyses showed a significant reduction in HADS factor scores over time, with less symptoms generally reported at 2 years following injury. However, in the cross-sectional sample analyses, participants tended to display early recovery on the HADS factor scores, with a plateau in their HADS scores between 6 months and 24 months, or an increase in HADS scores over these later time periods. Across the 2-year period, participants HADS depression and psychomotor scores generally remained higher than the mean normative scores provided by Dunbar et al. (2011), although little difference was found in regards to anxiety scores.

Participants differed in their emotional outcome based upon the psychological/physiological variables examined, with large effect sizes generally noted. Greater levels of pain and fatigue, and lower levels of SQOL and increased severity of post-concussion symptoms were associated with higher levels of anxiety, depression, and psychomotor symptoms across the 2-year post-injury period. The results from the multiple regression analyses indicated a number of variables tended to provide large statistically significant unique contributions to the regression models predicting participants HADS scores, including: pain, QOLI, RPQ, and the HADS Anxiety, Depression, and Psychomotor factors. The following Study (Study 4) will examine whether these psychological/physiological risk factors can be used in combination with demographic and clinical variables, to significantly predict TBI patients' HADS factor scores at a number of follow-up assessments following TBI.

Chapter 8

Study 4 - Predicting HADS scores Following TBI

The previous studies explored the influence of a number of variables on mood outcome following TBI, including demographic, clinical, and psychological/physiological variables. Study 4 aimed to determine which combination of these variables would provide the best prediction of TBI participants' mood outcome over a 2-year period.

8.1 Research Questions

1) *Prediction from the initial follow-up:* Multiple regression will be performed to identify which of the demographic, clinical, and psychological/physiological variables (discussed in Chapter 2) measured at the initial follow-up will significantly predict the HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI.
2) *Prediction from the 1-month follow-up:* Multiple regression will be performed to identify which of the demographic, clinical, and psychological/physiological variables (discussed in Chapter 2) measured at the 1-month follow-up will significantly predict the HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI.

8.2 Method

8.2.1 Participants. There were 1,260 cases identified from a database at the Neuro Trauma Register, on the basis of existing research on TBI. From these cases, 216 participants were excluded, as they did not attend follow-up assessments within defined periods of time post-TBI (see Chapter 5 – Section 5.2.6). The final total sample for Study 4 consisted of 1,044 participants (aged 16–91 years) who completed the HADS following a TBI. Due to missing data at each follow-up assessment, the numbers of participants varied in the analyses and are shown in 'Output – Study 4' (Appendix E on the CD).

8.2.2 Materials. Materials are identical to those used in Studies 1, 2, and 3.

8.2.3 Procedure. Procedure was identical to the procedure of Studies 1, 2, and 3.

8.2.4 Design. A multiple regression design was employed to examine whether demographic, clinical, and psychological/physiological variables at the initial follow-up assessment and 1-month follow-up assessment could be used to predict mood outcome at the 3-, 6-, 12-, and 24-month follow-ups. The independent variables (predictor variables) were the demographic (gender, age, NART, employment, SES, and relationship status), clinical (hospitalisation, PTA, orthopaedic injury, and cause of injury) and psychological/physiological (pain, fatigue, RPQ, and QOLI) variables examined in Studies 1 to 3. To determine if different methods of categorizing variables had an effect on the prediction of HADS factor scores, different variants of these variables were included in the analyses (e.g., NART FSIQ total scores as well as NART 2 and 3 groups). The HADS Anxiety, Depression, and Psychomotor raw factor scores were the dependent variables (outcome variables).

Additional multiple regression analyses were conducted to assess which combination of *clinician variables* (i.e., those variables readily/more easily available to the clinician) would provide the best regression equations for predicting HADS factor scores from the data collected at the initial and 1-month follow-ups. The variables included in these analyses are listed below:

- Age (years)
- Hospitalisation (days)
- Gender
- Relationship status
- PTA (days)
- Employment
- RPQ (total score)
- MVA/Assault vs.

- Pain (3 groups)
- Fatigue (3 groups)
- Anxiety (HADS factor score)
- Depression (HADS factor score)
- Psychomotor (HADS factor score)

8.2.5 Data analysis. To examine the relationship between the predictor variables and the dependent variables, preliminary regression analyses involved entering all predictor variables into the equation. Linear stepwise regression was then conducted where variables were selected based upon mathematical criteria (Tabachnick & Fidell, 2000). Probability of .15 for entry was chosen as Bendel and Afifi (1977 cited in Tabachnick & Fidell, 2000) recommend a liberal criterion for entry in order to capture important variables that would otherwise be excluded from the model.

Stepwise regression is a common statistical technique used for prediction in TBI research (see a systematic review of prediction of outcome in TBI by Mushkudiani et al., 2008). It has been employed in a number of studies predicting scores on the HADS (Jadoulle, Hoyois, & Jadoul, 2005; Kennedy, Lude, Elfstrom & Smithson, 2011; Mensah et al., 2006). Stepwise regression is a useful method in certain circumstances where the sample is large and highly representative of the population investigated (Tabachnick & Fidell, 2000). The present research had the rare opportunity to investigate a clinical population of TBI patients. As little previous research has examined the prediction of HADS scores in TBI populations, the present study employed stepwise regression as an exploratory technique to eliminate superfluous variables and to provide a model to guide future research (Tabachnick & Fidell, 2000).

8.3 Results

8.3.1 Initial Follow-up Predictors

Regression models. A series of stepwise multiple regression analyses were conducted to assess which combination of the demographic, clinical, and psychological/physiological variables from Studies 1–3 would provide the best regression equations for predicting HADS factor scores from the data collected at the initial follow-up. Regression models were produced for predicting HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI. At each of these follow-up assessments, two sets of regression analyses were performed to determine the role of HADS predictor variables in predicting HADS dependent variables: *including* the HADS factors as predictor variables and *excluding* the HADS factors as predictor variables. Sample sizes varied across the regression analyses (predicting 3 months [n = 125–280]; predicting 6 months [n = 117–274]; predicting 12 months [n = 160–236]; predicting 24 months [n = 93–216]).

Predictors entered into the regression models were chosen based on their performance in the preliminary regression analyses in Studies 1–3 (i.e., if they had contributed to the preliminary regression models or their p value suggested they were close to contributing to the preliminary regression models but were just outside the p value criterion for inclusion). Means, standard deviations, and Pearson correlation coefficients for the regression analyses predicting HADS factor scores are shown in 'Output – Study 4' (Appendix E on the CD).

Medium sized significant correlations ($p < .001$) were found between RPQ (total) and anxiety (r = .39 to .49), depression (r = .34 to .40), and psychomotor (r = .31 to .47) at each follow-up. At each follow-up assessment, initial anxiety showed medium to large significant ($p < .001$) correlations with anxiety (r = .53 to .68), depression (r = .36 to .51), and psychomotor (r = .40 to .54).

Initial depression showed moderate and large significant ($p < .001$) correlations with depression at 3 months ($r = .56$), 6 months ($r = .46$), and 12 months ($r = .39$). Medium significant correlations ($p < .001$) were found when initial psychomotor was correlated with each of the HADS factors at 12- and 24-months ($r = .41$ to $.45$). Large significant correlations ($p < .001$) were found between initial psychomotor and psychomotor measured at 3 months ($r = .56$) and 6 months ($r = .54$).

Pain (3 groups) showed medium sized significant correlations ($p < .001$) with anxiety ($r = .39$) and psychomotor ($r = .36$) at 3 months. There was a medium sized significant correlation ($p < .001$) between fatigue (total) and depression at 3 months ($r = .31$). QOLI (total) showed medium sized significant correlations ($p < .001$) with depression ($r = -.34$) and psychomotor ($r = -.32$) at 3 months.

The final prediction models are displayed in Tables 8.1, 8.3, 8.5, and 8.7, with the accompanying regression equations presented in Tables 8.2, 8.4, 8.6, and 8.8. A range of initial predictor variables were found to significantly predict HADS scores at the later follow-up assessments. Each of the regression models predicting from the initial follow-up was highly significant ($p < .001$) and tended to account for a substantial proportion of the variance in participants' HADS scores (10–56%). The strongest models were found when predicting HADS factor scores at the earlier follow-ups (3 months: 31–56% of the variance; 6 months: 22–45% of the variance). However, a considerable proportion of the variance in HADS scores was also explained when predicting HADS factor scores at the later follow-ups (12 months: 13–35%; 24 months: 10–35%).

Although more variance was explained by including the HADS factors as predictor variables (17–56%), a substantial proportion of the variance was still accounted for when the HADS factors were removed as predictors (10–42%). For instance, 42% of the variance in participants' depression scores at 3 months was accounted for by a combination of the

predictors: RPQ (Step 1 – 16%), QOLI (Step 2 – 26%), age (Step 3 – 32%), NART FSIQ (Step 4 – 41%), and 'MVA vs. other TBI causes' (R^2 = .42, F = 11.47 [5, 78], p < .001). It should be noted that occasionally a variable was included in a model adding a small percentage of variance explained, but did not reach statistical significance.

Clinician Predictors. A series of stepwise multiple regression analyses were conducted to assess which combination of clinician variables (i.e., those variables readily/more easily available to the clinician; see Section 8.2.4) would provide the best regression equations for predicting HADS factor scores from the data collected at the initial follow-up. The final models and equations are presented at the bottom of Tables 8.1–8.8.

The results indicated the clinician variable models accounted for between 13–51% of the variance in participants' HADS factor scores. These were important findings, for instance, 51% of the variance in participants' anxiety scores at 3 months was accounted for by a combination of the predictors: initial HADS anxiety (Step 1 – 46%), RPQ (Step 2 – 49%), and pain (3 groups) [R^2 = .51, F = 51.83 (3, 149), p < .001].

Table 8.1

Predicting HADS Scores at 3-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. RPQ*** – 24% 2. Pain (3 groups)* – 29% 3. QOLI – 32% p = .065	1. INIT Anxiety*** – 46% 2. QOLI* – 50% 3. RPQ – 53% p = .074 4. Pain (3 groups) – 54% p = .109	1. RPQ*** – 16% 2. QOLI*** – 26% 3. Age*** – 32% 4. NART FSIQ*** – 41%	1. INIT Depression*** – 31% 2. QOLI*** – 39% 3. INIT Anxiety** – 46% 4. Age*** – 50% 5. NART FSIQ** – 55%	1. RPQ*** – 22% 2. QOLI** – 29% 3. Pain (3 groups)* – 33%	1. INIT Psychomotor** – 31% 2. INIT Anxiety** – 37% 3. QOLI* – 42% 4. Pain (3 groups) – 44% p = .148
All variables expected to predict	1. RPQ*** – 24% 2. Pain (3 groups)* – 29% 3. QOLI – 32% p = .065	1. INIT Anxiety*** – 46% 2. QOLI* – 50% 3. RPQ – 53% p = .074 4. Pain (3 groups) – 54% p = .109	1. RPQ*** – 16% 2. QOLI*** – 26% 3. Age*** – 32% 4. NART FSIQ*** – 41% 5. MVA vs. – 42% p = .128	1. INIT Depression*** – 31% 2. QOLI*** – 39% 3. INIT Anxiety** – 46% 4. Age*** – 50% 5. NART FSIQ** – 55% 6. MVA vs. – 56% p = .120	1. RPQ*** – 22% 2. QOLI*** – 29% 3. Age** – 35% 5. NART FSIQ** – 39%	1. INIT Psychomotor – 31% p = .122 2. INIT Anxiety* – 37% 3. QOLI*** – 42% 4. Age* – 46% 5. RPQ* – 48% 6. NART FSIQ* – 50%
Clinician variables	1. RPQ*** – 24% 2. Pain (3 groups)*** – 29%	1. INIT Anxiety*** – 46% 2. RPQ* – 49% 3. Pain (3 group)* – 51%	1. RPQ*** - 16% 2. Age* – 19% 3. Relationship* – 21% 4. Fatigue* – 23%	1. INIT Depression*** – 31% 2. INIT Anxiety*** – 37% 3. Age* – 39% 4. Relationship – 40% p = .090 5. RPQ – 41% p = .126	1. RPQ*** – 22% 2. Pain (3 groups)** – 27% 3. Relationship** – 29% 4. Age – 31% p = .070	1. INIT Psychomotor** – 31% 2. INIT Anxiety** – 37% 3. Pain (3 groups)* – 39% 4. RPQ* – 41% 5. Relationship* – 42% 6. Age – 44% p = .054

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.2

Regression Equations Predicting HADS Scores at 3-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = .672 + .076 (RPQ) + .896 (Pain 3 groups) + -.329 (QOLI)	*Y* = .550 + .546 (INIT Anxiety) + -.350 (QOLI) + .031 (RPQ) + .509 (Pain 3 groups)	*Y* = 5.317 + .047 (RPQ) + -.525 (QOLI) + .031 (Age) + -.047 (NART FSIQ)	*Y* = 4.263 + .329 (INIT Depression) + -.473 (QOLI) + .184 (INIT Anxiety) + .025 (Age) + -.037 (NARTFSIQ)	*Y* = 1.885 + .068 (RPQ) + -.435 (QOLI) + .720 (Pain 3 groups)	*Y* = 1.343 + .218 (INIT Psychomotor) + .259 (INIT Anxiety) + -.395 (QOLI) + .466 (Pain 3 groups) + .027 (RPQ)
All variables expected to predict	*Y* = .672 + .076 (RPQ) + .896 (Pain 3 groups) + -.329 (QOLI)	*Y* = .550 + .546 (INIT Anxiety) + -.350 (QOLI) + .031 (RPQ) + .509 (Pain 3 groups)	*Y* = 6.390 + .046 (RPQ) + -.546 (QOLI) + .032 (Age) + - .049 (NART FSIQ) + -.459 (MVA vs.)	*Y* = 5.217+ .317 (INIT Depression) + -.494 (QOLI) + .183 (INIT Anxiety) + .026 (Age) + -.039 (NART FSIQ) + -.412 (MVA vs.)	*Y* = 7.539 + .078 (RPQ) + -.585 (QOLI) + .033 (Age) + -.055 (NART FSIQ)	*Y* = 5.118 + .191 (INIT Psychomotor) + .259 (Anxiety) + -.524 (QOLI) + .029 (Age) + .037 (RPQ) + -.039 (NART FSIQ)
Clinician variables	*Y* = -.354 + .078 (RPQ) + .933 (Pain 3 groups)	*Y* = -.540 + .541 (INIT Anxiety) + .033 (RPQ) + .551 (Pain 3 groups)	*Y* = -1.530 + .046 (RPQ) + .017 (Age) + .490 (Relationship) + .103 (Fatigue)	*Y* = -1.163 + .337 (INIT Depression) + .178 (INIT Anxiety) + .013 (Age) + .354 (Relationship) + .015 (RPQ)	*Y* = -1.327 + .075 (RPQ) + .728 (Pain 3 groups) + .813 (Relationship) + .016 (Age)	*Y* = -1.531 + .266 (INIT Psychomotor) + .224 (INIT Anxiety) + .481 (Pain 3 groups) + .032 (RPQ) + .645 (Relationship) + .015 (Age)

Table 8.3

Predicting HADS Scores at 6-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. RPQ*** – 16% 2. NART (4 groups)* – 20% 3. QOLI (2 groups) – 24% p = .059	1. INIT Anxiety*** – 38% 2. QOLI (2 groups)* – 43% 3. Pain (3 groups) – 45% p = .092	1. RPQ*** – 13% 2. Age (4 groups)*** – 23% 3. QOLI*** – 34% 4. NART FSIQ* – 38%	1. INIT Depression* – 21% 2. QOLI*** – 28% 3. Age (4 groups)*** – 37% 4. NART FSIQ – 40% p = .068 5. RPQ – 42% p = .073	1. RPQ*** – 19% 2. QOLI*** – 25% 3. Age** – 29% 4. NART FSIQ* – 34%	1. INIT Psychomotor** – 29% 2. QOLI** – 33% 3. INIT Anxiety* – 37% 4. Age* – 40%
All variables expected to predict	1. RPQ*** – 16% 2. NART (4 groups)** – 20% 3. QOLI (2 groups)* – 24% 4. Age* – 28%	1. INIT Anxiety*** – 38% 2. QOLI (2 groups)* – 43% 3. Pain (3 groups) – 45% p = .092	1. RPQ*** – 13% 2. Age (4 groups)*** – 23% 3. QOLI*** – 34% 4. NART FSIQ* – 38%	1. INIT Depression* – 21% 2. QOLI*** – 28% 3. Age (4 groups)*** – 37% 4. NART FSIQ – 40% p = .068 5. RPQ – 42% p = .073	1. RPQ*** – 19% 2. QOLI*** – 25% 3. Age** – 29% 4. NART FSIQ* – 34%	1. INIT Psychomotor** – 29% 2. QOLI** – 33% 3. INIT Anxiety* – 37% 4. Age* – 40%
Clinician Variables	1. RPQ*** – 16% 2. Pain (3 groups)** – 20% 3. Employment – 22% p = .052	1. INIT Anxiety*** – 38% 2. Hosp (days)** – 40% 3. Pain (3 groups)* – 42% 4. RPQ – 43% p = .077 5. Age – 43% p = .093	1. RPQ*** – 13% 2. Age*** – 22% 3. Relationship – 23% p = .122 4. Pain (3 groups) – 23% p = .145	1. INIT Depression*** – 21% 2. Age*** – 26% 3. RPQ** – 29% 4. Anxiety* – 31% 5. Relationship – 31% p = .097 6. MVA/Assault vs. – 32% p = .103	1. RPQ*** – 19% 2. Age** – 21% 3. Hosp (days) – 22% p = .129 4. Pain (3 groups) – 23% p = .130	1. INIT Psychomotor*** – 29% 2. INIT Anxiety** – 32% 3. Age** – 33% 4. RPQ* – 35% 5. Hosp (days)* – 36%

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.4

Regression Equations Predicting HADS Scores at 6-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = 3.916 + .060 (RPQ) + -.470 (NART 4 groups) + -1.005 (QOLI 2 groups)	*Y* = 1.755 + .529 (INIT Anxiety) + -1.144 (QOLI 2 groups) + .525 (Pain 3 groups)	*Y* = 2.835 + .039 (RPQ) + .659 (Age 4 groups) + -.398 (QOLI) + -.028 (NART FSIQ)	*Y* = 2.478 + .225 (INIT Depression) + -.368 (QOLI) + .582 (Age 4 groups) + -.025 (NART FSIQ) + .023 (RPQ)	*Y* = 5.806 + .063 (RPQ) + -.471 (QOLI) + .035 (Age) + -.044 (NART FSIQ)	*Y* = 1.080 + .318 (INIT Psychomotor) + -.390 (QOLI) + .215 (INIT Anxiety) + .022 (Age)
All variables expected to predict	*Y* = 3.728 + .061 (RPQ) + -.634 (NART 4 groups) + -1.247 (QOLI 2 groups) + .028 (Age)	*Y* = 1.755 + .529 (INIT Anxiety) + -1.144 (QOLI 2 groups) + .525 (Pain 3 groups)	*Y* = 2.835 + .039 (RPQ) + .659 (Age 4 groups) + -.398 (QOLI) + -.028 (NART FSIQ)	*Y* = 2.478 + .225 (INIT Depression) + -.368 (QOLI) + .582 (Age 4 groups) + -.025 (NART FSIQ) + .023 (RPQ)	*Y* = 5.806 + .063 (RPQ) + -.471 (QOLI) + .035 (Age) + -.044 (NART FSIQ)	*Y* = 1.080 + .318 (INIT Psychomotor) + -.390 (QOLI) + .215 (INIT Anxiety) + .022 (Age)
Clinician Variables	*Y* = -1.169 + .061 (RPQ) + .653 (Pain 3 groups) + .899 (Employment)	*Y* = -.707 + .509 (INIT Anxiety) + -.029 (Hospitalisation days) + .406 (Pain 3 groups) + .019 (RPQ) + .011 (Age)	*Y* = -1.593 + .045 (RPQ) + .027 (Age) + .284 (Relationship) + .222 (Pain 3 groups)	*Y* = -1.706 + .232 (INIT Depression) + .021 (Age) + .023 (RPQ) + .111 (INIT Anxiety) + .288 (Relationship) + .293 (MVA/Assault vs.)	*Y* = .194 + .069 (RPQ) + .018 (Age) + -.019 (Hospitalisation days) + .315 (Pain 3 groups)	*Y* = -.068 + .305 (INIT Psychomotor) + .185 (INIT Anxiety) + .017 (Age) + .025 (RPQ) + -.024 (Hospitalisation days)

Table 8.5

Predicting HADS Scores at 12-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. RPQ*** – 16% 2. Pain*** – 21% 3. Hosp (2 groups)* – 23% 4. PTA total – 24% *p* = .111	1. INIT Anxiety*** – 28% 2. Pain** – 32% 3. PTA total – 34% *p* = .071 4. RPQ – 35% *p* = .100	1. RPQ*** – 13%	1. INIT Psychomotor*** – 17% 2. Age*** – 22% 3. RPQ* – 25% 4. NART FSIQ* – 27%	1. RPQ*** – 15% 2. NART FSIQ* – 18%	1. INIT Psychomotor*** – 22% 2. RPQ* – 24% 3. NART FSIQ* – 26%
All variables expected to predict	1. RPQ*** – 16% 2. Pain*** – 21% 3. Hosp (2 groups)* – 23% 4. PTA total – 24% *p* = .111	1. INIT Anxiety*** – 28% 2. Pain** – 32% 3. PTA total – 34% *p* = .071 4. RPQ – 35% *p* = .100	1. RPQ*** – 13% 2. Age*** – 18% 3. NART FSIQ** – 21%	1. INIT Psychomotor*** – 17% 2. Age*** – 22% 3. RPQ* – 25% 4. NART FSIQ* – 27%	1. RPQ*** – 15% 2. NART FSIQ* – 18% 3. Age – 21% *p* = .075	1. INIT Psychomotor*** – 22%
Clinician Variables	1. RPQ*** – 16% 2. Pain (3 groups)** – 19%	1. INIT Anxiety*** – 28% 2. Pain (3 groups) – 31% *p* = .058 3. PTA total – 32% *p* = .113 4. RPQ – 34% *p* = .128	1. RPQ*** – 13% 2. Age*** – 18% 3. Pain (3 groups) – 20% *p* = .099 4. Gender – 21% *p* = .125 5. Employment – 22% *p* = .149	1. INIT Psychomotor*** – 17% 2. Age*** – 22% 3. RPQ* – 25% 4. Employment – 26% *p* = .098	1. RPQ*** – 15% 2. Pain (3 groups) – 17% *p* = .065 3. Age – 18% *p* = .063 4. Gender – 20% *p* = .096	1. INIT Psychomotor** – 22% 2. RPQ – 24% p = .105 3. Age* – 26% 4. Employment - 27% *p* = .136 5. Gender – 28% *p* = .074 6. INIT Anxiety – 29% *p* = .120 7. Pain (3 groups) – 30% *p* = .149

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.6

Regression Equations Predicting HADS Scores at 12-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = 1.090 + .053 (RPQ) + .192 (Pain) + -.579 (Hosp 2 groups) + .112 (PTA total)	*Y* = -.005 + .384 (INIT Anxiety) + .146 (Pain) + .118 (PTA total) + .020 (RPQ)	*Y* = .209 + .046 (RPQ)	*Y* = 1.188 + .225 (INIT Psychomotor) + .024 (Age) + .025 (RPQ) + -.023 (NART FSIQ)	*Y* = 4.823 + .068 (RPQ) + -.035 (NART FSIQ)	*Y* = 3.867 + .369 (INIT Psychomotor) + .032 (RPQ) + -.032 (NART FSIQ)
All variables expected to predict	*Y* = 1.090 + .053 (RPQ) + .192 (Pain) + -.579 (Hosp 2 groups) + .112 (PTA total)	*Y* = -.005 + .384 (INIT Anxiety) + .146 (Pain) + .118 (PTA total) + .020 (RPQ)	*Y* = 1.778 + .047 (RPQ) + .025 (Age) + - .025 (NART FSIQ)	*Y* = 1.188 + .225 (INIT Psychomotor) + .024 (Age) + .025 (RPQ) + -.023 (NART FSIQ)	*Y* = 5.416 + .070 (RPQ) + -.050 (NART FSIQ) + .024 (Age)	*Y* = .792 + .481 (INIT Psychomotor)
Clinician Variables	*Y* = -.068 + .062 (RPQ) + .607 (Pain 3 groups)	*Y* = -.282 + .393 (INIT Anxiety) + .468 (Pain 3 groups) + .123 (PTA total) + .023 (RPQ)	*Y* = -2.324 + .045 (RPQ) + .022 (Age) + .319 (Pain 3 groups) + .386 (Gender) + .473 (Employment)	*Y* = -1.682 + .238 (INIT Psychomotor) + .021 (Age) + .024 (RPQ) + .527 (Employment)	*Y* = -1.018 + .065 (RPQ) + .493 (Pain 3 groups) + .017 (Age) + .580 (Gender)	*Y* = -2.340 + .282 (INIT Psychomotor) + .026 (RPQ) + .018 (Age) + .640 (Employment) + .594 (Gender) + .139 (INIT Anxiety) + .365 (Pain 3 groups)

Table 8.7

Predicting HADS Scores at 24-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. RPQ*** – 15% 2. Pain*** – 19%	1. INIT Anxiety*** – 32% 2. Pain** – 35%	1. RPQ*** – 11%	1. INIT Anxiety*** – 17% 2. RPQ* – 19%	1. Pain*** – 10%	1. INIT Psychomotor*** – 21% 2. Pain** – 25%
All variables expected to predict	1. RPQ** – 15% 2. Pain – 19% p = .057 3. QOLI – 21% p = .132	1. INIT Anxiety*** – 32% 2. Pain** – 35%	1. RPQ*** – 11% 2. Pain (3 groups) – 13% p = .070	1. INIT Anxiety*** – 17% 2. RPQ – 19% p = .077 3. Pain (3 groups) – 20% p = .111	1. Pain* – 10% 2. RPQ – 14% p = .065 3. QOLI – 17% p = .098	1. INIT Psychomotor* – 21% 2. Pain – 25% p = .060 3. INIT Anxiety – 27% p = .087
Clinician Variables	1. RPQ*** – 15% 2. Pain (3 groups) – 17% p = .083	1. INIT Anxiety*** – 32% 2. Pain (3 groups) – 34% p = .054	1. RPQ*** – 11% 2. Pain (3 groups) – 13% p = .136	1. INIT Anxiety* – 17% 2. INIT Psychomotor* – 20% 3. Pain (3 groups) – 22% p = .116	1. RPQ** – 1% 2. Pain (3 groups)* – 14%	1. INIT Psychomotor** – 21% 2. Pain (3 groups)* – 25% 3. INIT Anxiety* – 27%

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.8

Regression Equations Predicting HADS Scores at 24-Months from Variables Measured at the Initial Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = .666 + .059 (RPQ) + .168 (Pain)	*Y* = .349 + .495 (INIT Anxiety) + .146 (Pain)	*Y* = .326 + .047 (RPQ)	*Y* = .046 + .233 (INIT Anxiety) + .025 (RPQ)	*Y* = 1.715 + .268 (Pain)	*Y* = .461 + .421 (INIT Psychomotor) + .172 (Pain)
All variables expected to predict	*Y* = 1.469 + .055 (RPQ) + .169 (Pain) + -.251 (QOLI)	*Y* = .349 + .495 (INIT Anxiety) + .146 (Pain)	*Y* = -.116 + .041 (RPQ) + .361 (Pain 3 groups)	*Y* = -.320 + .226 (INIT Anxiety) + .020 (RPQ) + .305 (Pain 3 groups)	*Y* = 2.121 + .200 (Pain) + .036 (RPQ) + -.278 (QOLI)	*Y* = .460 + .284 (INIT Psychomotor) + .154 (Pain) + .197 (INIT Anxiety)
Clinician Variables	*Y* = .364 + .063 (RPQ) + .534 (Pain 3 groups)	*Y* = .037 + .509 (INIT Anxiety) + .511 (Pain 3 groups)	*Y* = -.116 + .041 (RPQ) + .361 (Pain 3 groups)	*Y* = -.555 + .171 (INIT Anxiety) + .182 (Psychomotor) + .352 (Pain 3 groups)	*Y* = .722 + .043 (RPQ) + .756 (Pain 3 groups)	*Y* = -.056 + .297 (INIT Psychomotor) + .655 (Pain 3 groups) + .197 (INIT Anxiety)

8.3.2 One-month Follow-up Predictors.

Regression models. A series of stepwise multiple regression analyses were also conducted to assess which combination of the demographic, clinical, and psychological/physiological variables from Studies 1–3 would provide the best regression equations for predicting HADS factor scores from the data collected at the 1-month follow-up. Sample sizes varied across the regression analyses (predicting 3 months [n = 190–271]; predicting 6 months [n = 163–266]; predicting 12 months [n = 150–228]; and predicting 24 months [n = 129–208]). Means, standard deviations, and Pearson correlation coefficients for the regression analyses predicting HADS factor scores are shown in 'Output – Study 4' (Appendix E on the CD).

Medium and large significant ($p < .001$) correlations were found between RPQ (total) and anxiety (r = .39 to .52), depression (r = .40 to .47) and psychomotor (r = .44 to .58) at each follow-up. Medium sized significant correlations ($p < .001$) in a negative direction ($p < .001$) were found between QOLI (total) and depression (r = -.32 to -.40) and psychomotor (r = -.31 to - .41) at each follow-up, as well as between QOLI (total) and anxiety at 3 months (r = -.33).

Medium sized significant correlations ($p < .001$) were found: between pain (3 groups) and anxiety at 3 months (r = .33), 12 months (r = .33), and 24 months (r = .39); between pain (3 groups) and depression at 3 months (r = .32), 6 months (r = .32), and 24 months (r = .39); and between pain (3 groups) and psychomotor at 3 months (r = .36), 12 months (r = .33), and 24 months (r = .45). At 3 months there were medium sized significant correlations ($p < .001$) between fatigue (3 groups) and anxiety (r = .32), and between fatigue (3 groups) and psychomotor (r = .31).

Large significant correlations ($p < .001$) were found between 1-month anxiety and anxiety (r = .62 to .76) and psychomotor (r = .51 to .63) at each follow-up, and between 1-month anxiety and depression at 3 months (r = .51). Large significant correlations ($p < .001$) were found between 1-month depression and depression at each follow-up (r = .55

to .69), and 1-month depression and anxiety at 12 months (r = .53). There was a medium significant correlation (p < .001) between 1-month depression and anxiety at 24 months (r = .41). There were large significant correlations (p < .001) between 1-month psychomotor and depression (r = .55 to .59) and psychomotor (r = .63 to .72) at each follow-up. Large significant correlations (p < .001) were found between 1-month psychomotor and anxiety at 6 months (r = .57), 12 months (r = .57), and 24 months (r = .52).

The final prediction models are displayed in Tables 8.9, 8.11, 8.13, and 8.15, with the accompanying regression equations presented in Tables 8.10, 8.12, 8.14, and 8.16. A range of 1-month predictor variables were found to significantly predict HADS scores at the later follow-up assessments. Each of the regression models predicting from the 1-month follow-up was highly significant (p < .001) and tended to account for a substantial proportion of the variance in participants' HADS scores (20–64%). A considerable proportion of the variance in HADS scores was explained when predicting each of the follow-up points: 3 months (31–64%), 6 months (26–55%), 12 months (20–52%), and 24 months (23–47%).

The findings suggest that although more variance was explained by adding the HADS factors as predictor variables (39–64%), a substantial proportion of the variance was still accounted for when the HADS were removed as predictors (20–47%). For instance, 47% of the variance in participants' psychomotor scores at 3 months was accounted for by a combination of the predictors: RPQ (Step 1 – 34%), NART FSIQ (Step 2 – 39%), QOLI (Step 3 – 45%), and age (R^2 = .47, F = 31.99 [4, 143], p < .001).

As with the initial follow-up regression models, occasionally a variable was included in a model adding a small percentage of variance explained, but did not reach statistical significance. In contrast to the initial follow-up regression models, occasionally, different variants of the same variable were included in a model, increasing the overall percentage of variance accounted for by the model. For example, QOLI (total score) and QOLI (4 groups; see Table 8.9).

Clinician predictors. A series of stepwise multiple regression analyses were conducted to assess which combination of clinician variables would provide the best regression equations for predicting HADS factor scores from the data collected at the 1-month follow-up. The final models and equations are presented at the bottom of Tables 8.9–8.16.

The results indicated the clinician variable models accounted for between 20–59% of the variance in participants' HADS factor scores. These were important findings, for instance 59% of the variance in participants' anxiety scores at 3 months was accounted for by a combination of the predictors: 1-month anxiety (Step 1 – 58%) and relationship status ($R^2 = .59$, $F = 100.15$ [2, 137], $p < .001$).

Orthopaedic injury. As orthopaedic injury rarely featured in the models, further stepwise regression analyses were performed to determine whether orthopaedic injury would feature in the final regression models when pain predictor variables were removed (see 'Output – Study 4' in Appendix E on the CD). The results showed orthopaedic injury was not included in the final regression models when pain was removed, suggesting these variables do not share variance and play different roles in predicting HADS factor scores post-TBI.

Table 8.9

Predicting HADS Scores at 3-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. RPQ*** – 28% 2. NART FSIQ*** – 34% 3. QOLI*** – 37% 4. QOLI (4 groups)** – 40% 5. Fatigue (3 groups) – 41% p = .063	1. 1M Anxiety*** – 58% 2. NART FSIQ*** – 61% 3. QOLI*** – 61% 4. QOLI (4 groups)** – 64%	1. RPQ*** – 23% 2. QOLI*** – 29% 3. NART FSIQ*** – 37% 4. Age (4 groups)*** – 42%	1. 1M Depression*** – 47% 2. NART FSIQ*** – 53% 3. Age (4 groups)** – 55% 4. QOLI** – 57%	1. RPQ*** – 34% 2. NART FSIQ*** – 39% 3. QOLI*** – 45%	1. 1M Psychomotor*** – 52% 2. 1M Anxiety** – 57% 3. NART FSIQ** – 59% 4. RPQ – 60% p = .070
All variables expected to predict	1. RPQ*** – 28% 2. NART FSIQ*** – 34% 3. QOLI*** – 37% 4. QOLI (4 groups)** – 40% 5. Fatigue (3 groups) – 41% p = .063	1. 1M Anxiety*** – 58% 2. NART FSIQ*** – 61% 3. QOLI*** – 61% 4. QOLI (4 groups)** – 64%	1. RPQ*** – 23% 2. QOLI*** – 29% 3. NART FSIQ*** – 37% 4. Age*** – 42%	1. 1M Depression*** – 47% 2. NART FSIQ*** – 53% 3. Age*** – 55% 4. QOLI** – 58%	1. RPQ*** – 34% 2. NART FSIQ*** – 39% 3. QOLI*** – 45% 4. Age* – 47%	1. 1M Psychomotor*** – 52% 2. 1M Anxiety*** – 57% 3. NART FSIQ*** – 59% 4. Relationship* – 60% 5. Age* – 61% 6. QOLI – 62% p = .081
Clinician Variables	1. RPQ*** – 28% 2. Fatigue (3 groups) – 30% p = .059 3. Pain (3 groups) – 31% p = .124	1. 1M Anxiety*** – 58% 2. Relationship – 59% p = .077	1. RPQ*** – 23% 2. Pain (3 groups) – 24% p = .119	1. 1M Depression*** – 47% 2. Anxiety* – 49% 3. Relationship – 50% p = .052	1. RPQ*** – 34% 2. Pain (3 groups) – 35% p = .104 3. Fatigue (3 groups) – 36% p = .133	1. 1M Psychomotor*** – 52% 2. 1M Anxiety** – 57% 3. Relationship – 58% p = .055 4. RPQ – 59% p = .123

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.10

Regression Equations Predicting HADS Scores at 3-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = 5.682 + .068 (RPQ) + -.055 (NART FSIQ) + -.608 (QOLI) + .604 (QOLI 4 groups) + .469 (Fatigue 3 groups)	*Y* = 3.604 + .700 (1M Anxiety) + -.036 (NART FSIQ) + -.466 (QOLI) + .560 (QOLI 4 groups)	*Y* = 6.231 + .034 (RPQ) + -.331 (QOLI) + -.056 (NART FSIQ) + .385 (Age 4 groups)	*Y* = 5.104 + .517 (1M Depression) + -.048 (NART FSIQ) + .273 (Age 4 groups) + -.169 (QOLI)	*Y* = 7.832 + .078 (RPQ) + -.052 (NART FSIQ) + -.343 (QOLI)	*Y* = 3.815 + .432 (1M Psychomotor) + .206 (1M Anxiety) + -.031 (NART FSIQ) + .023 (RPQ)
All variables expected to predict	*Y* = 5.682 + .068 (RPQ) + -.055 (NART FSIQ) + -.608 (QOLI) + .604 (QOLI 4 groups) + .469 (Fatigue 3 groups)	*Y* = 3.604 + .700 (1M Anxiety) + -.036 (NART FSIQ) + -.466 (QOLI) + .560 (QOLI 4 groups)	*Y* = 6.434 + .032 (RPQ) + -.351 (QOLI) + -.058 (NART FSIQ) + .024 (Age)	*Y* = 5.221 + .510 (1M Depression) + -.050 (NART FSIQ) + .018 (Age) + -.182 (QOLI)	*Y* = 8.637 + .071 (RPQ) + -.066 (NART FSIQ) + -.398 (QOLI) + .020 (Age)	*Y* = 4.399 + .411 (1M Psychomotor) + .241 (1M Anxiety) + -.043 (NART FSIQ) + .477 (Relationship) + .014 (Age) + -.146 (QOLI)
Clinician Variables	*Y* = -.398 + .078 (RPQ) + .530 (Fatigue 3 groups) + .490 (Pain 3 groups)	*Y* = -.252 + .775 (1M Anxiety) + .445 (Relationship)	*Y* = -.196 + .054 (RPQ) + .367 (Pain 3 groups)	*Y* = -.478 + .573 (1M Depression) + .112 (1M Anxiety) + .383 (Relationship)	*Y* = .265 + .087 (RPQ) + .482 (Pain 3 groups) + .391 (Fatigue 3 groups)	*Y* = -.149 + .439 (1M Psychomotor) + .246 (1M Anxiety) + .478 (Relationship) + .021 (RPQ)

Table 8.11

Predicting HADS Scores at 6-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. RPQ*** – 21% 2. NART FSIQ*** – 27%	1. 1M Anxiety*** – 52% 2. 1M Psychomotor* – 54% 3. NART FSIQ* – 55%	1. RPQ*** – 22% 2. Age (4 groups)*** – 27% 3. NART FSIQ* – 30%	1. 1M Depression*** – 40% 2. 1M Psychomotor – 42% p = .111 3. Age (4 groups)** – 45% 4. NART FSIQ – 46% p = .055 5. RPQ – 47% p = .137	1. RPQ*** – 29% 2. NART FSIQ** – 33%	1. 1M Psychomotor*** – 47% 2. RPQ** – 49% 3. NART FSIQ* – 51%
All variables expected to predict	1. RPQ*** – 21% 2. NART FSIQ*** – 27%	1. 1M Anxiety*** – 52% 2. 1M Psychomotor* – 54% 3. NART FSIQ* – 55%	1. RPQ*** – 22% 2. Age (4 groups)*** – 27% 3. QOLI*** – 31% 4. NART FSIQ*** – 35% 5. Gender* – 37%	1. 1M Depression*** – 40% 2. 1M Psychomotor – 42% p = .111 3. Age (4 groups)** – 45% 4. NART FSIQ – 46% p = .055 5. RPQ – 47% p = .137	1. RPQ*** – 29% 2. NART FSIQ*** – 33% 3. QOLI** – 35% 4. Age* – 37% 5. Ortho (3 groups)* – 39%	1. 1M Psychomotor*** – 47% 2. Ortho (2 groups)** – 50% 3. RPQ* – 52% 4. NART FSIQ* – 52%
Clinician Variables	1. RPQ*** – 21% 2. Employment – 27% p = .086	1. 1M Anxiety*** – 52% 2. 1M Psychomotor – 54% p = .034	1. RPQ*** – 22% 2. Age** – 26%	1. 1M Depression*** – 40% 2. 1M Psychomotor** – 42% 3. Age* – 45% 4. Relationship – 46% p = .084 5. Gender – 47% p = .124	1. RPQ*** – 29% 2. Hosp (days) – 30% p = .140	1. 1M Psychomotor*** – 47% 2. 1M Anxiety – 49% p = .113 3. RPQ – 50% p = .119

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.12

Regression Equations Predicting HADS Scores at 6-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = 6.292 + .073 (RPQ) + -.054 (NART FSIQ)	*Y* = 2.440 + .564 (1M Anxiety) + .142 (1M Psychomotor) + -.023 (NART FSIQ)	*Y* = 2.148 + .057 (RPQ) + .401 (Age 4 groups) + -.028 (NART FSIQ)	*Y* = 1.361 + .398 (1M Depression) + .108 (1M Psychomotor) + .286 (Age 4 groups) + -.020 (NART FSIQ) + .016 (RPQ)	*Y* = 5.139 + .086 (RPQ) + -.038 (NART FSIQ)	*Y* = 3.015 + .479 (1M Psychomotor) + .029 (RPQ) + -.024 (NART FSIQ)
All variables expected to predict	*Y* = 6.292 + .073 (RPQ) + -.054 (NART FSIQ)	*Y* = 2.440 + .564 (1M Anxiety) + .142 (1M Psychomotor) + -.023 (NART FSIQ)	*Y* = 4.724 + .040 (RPQ) + .439 (Age 4 groups) + -.291 (QOLI) + -.036 (NART FSIQ) + -.492 (Gender)	*Y* = 1.361 + .398 (1M Depression) + .108 (1M Psychomotor) + .286 (Age 4 groups) + -.020 (NART FSIQ) + .016 (RPQ)	*Y* = 6.785 + .072 (RPQ) + -.052 (NART FSIQ) + -.250 (QOLI) + .018 (Age) + -.470 (Ortho 3 groups)	*Y* = 4.058 + .489 (1M Psychomotor) + -.827 (Ortho 2 groups) + .029 (RPQ) + -.024 (NART FSIQ)
Clinician Variables	*Y* = -.146 + .079 (RPQ) + .818 (Employment)	*Y* = .062 + .593 (1M Anxiety) + .148 (1M Psychomotor)	*Y* = -.521 + .061 (RPQ) + .019 (Age)	*Y* = -.494 + .426 (1M Depression) + .168 (1M Psychomotor) + .014 (Age) + .365 (Relationship) + -.337 (Gender)	*Y* = 1.279 + .092 (RPQ) + -.024 (Hosp days)	*Y* = .538 + .447 (1M Psychomotor) + .126 (1M Anxiety) + .022 (RPQ)

Table 8.13

Predicting HADS Scores at 12-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. RPQ*** – 27% 2. NART FSIQ – 29% p = .067 3. Pain (2 groups) - 30% p = .145	1. 1M Anxiety*** – 46% 2. 1M Depression*** – 49% 3. Pain (2 groups)* – 51% 4. PTA total – 52% p = .132	1. RPQ** – 17% 2. QOLI** – 19% 3. Age*** – 23% 4. NART FSIQ** – 27%	1. 1M Psychomotor** – 31% 2. 1M Depression** – 35% 3. Age* – 37% 4. NART FSIQ – 39% p = .083 5. PTA total – 40% p = .136	1. RPQ*** – 23% 2. NART FSIQ*** – 28% 3. QOLI** – 31% 4. Age* – 34%	1. 1M Psychomotor*** – 45% 2. NART FSIQ* – 47% 3. Pain (2 groups) – 49% p = .085 4. PTA total – 50% p = .109
All variables expected to predict	1. RPQ*** – 27% 2. NART FSIQ – 29% p = .067 3. Pain (2 groups) - 30% p = .145	1. 1M Anxiety*** – 46% 2. 1M Depression*** – 49% 3. Pain (2 groups)* – 51% 4. PTA total – 52% p = .132	1. RPQ** – 17% 2. QOLI** – 19% 3. Age*** – 23% 4. NART FSIQ** – 27%	1. 1M Psychomotor* – 31% 2. 1M Depression** – 35% 3. Age* – 37% 4. NART FSIQ – 39% p = .070	1. RPQ*** – 23% 2. NART FSIQ*** – 28% 3. QOLI* – 31% 4. Age** – 34% 5. TBI cause – 35% p = .123	1. 1M Psychomotor*** – 45% 2. NART FSIQ* – 47% 3. Pain (2 groups) – 49% p = .085 4. PTA total – 50% p = .109
Clinician Variables	1. RPQ*** – 27%	1. 1M Anxiety*** – 46% 2. 1M Depression** – 49% 3. Pain (3 groups) – 51% p = .088 4. PTA total – 52% p = .116	1. RPQ*** – 17% 2. Age* – 19% 3. Employment – 20% p = .144	1. 1M Psychomotor*** – 31% 2. 1M Depression* – 35% 3. Age – 37% p = .051 4. PTA total* – 39% 5. Employment – 40% p = .070	1. RPQ*** – 23% 2. Pain (3 groups) – 24% p = .147	1. 1M Psychomotor*** – 45% 2. PTA total* – 46% 3. Anxiety – 47% p = .148

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.14

Regression Equations Predicting HADS Scores at 12-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = 2.937 + .084 (RPQ) + -.030 (NART FSIQ) + .734 (Pain 2 groups)	*Y* = -.674 + .516 (1M Anxiety) + .274 (1M Depression) + .835 (Pain 2 groups) + .105 (PTA total)	*Y* = 3.497 + .035 (RPQ) + -.226 (QOLI) + .024 (Age) + -.033 (NART FSIQ)	*Y* = 1.449 + .192 (1M Psychomotor) + .270 (1M Depression) + .015 (Age) + -.020 (NART FSIQ) + .084 (PTA total)	*Y* = 8.004 + .063 (RPQ) + -.066 (NART FSIQ) + -.281 (QOLI) + .024 (Age)	*Y* = 2.882 + .548 (1M Psychomotor) + -.030 (NART FSIQ) + .715 (Pain 2 groups) + .115 (PTA total)
All variables expected to predict	*Y* = 2.937 + .084 (RPQ) + -.030 (NART FSIQ) + .734 (Pain 2 groups)	*Y* = -.674 + .516 (1M Anxiety) + .274 (1M Depression) + .835 (Pain 2 groups) + .105 (PTA total)	*Y* = 3.497 + .035 (RPQ) + -.226 (QOLI) + .024 (Age) + -.033 (NART FSIQ)	*Y* = 1.776 + .188 (1M Psychomotor) + .284 (1M Depression) + .017 (Age) + -.024 (NART FSIQ)	*Y* = 7.023 + .065 (RPQ) + -.063 + -.270 (QOLI) + .027 (Age) + .214 (TBI cause)	*Y* = 2.882 + .548 (1M Psychomotor) + -.030 (NART FSIQ) + .715 (Pain 2 groups) + .115 (PTA total)
Clinician Variables	*Y* = .588 + .095 (RPQ)	*Y* = -.309 + .522 (1M Anxiety) + .260 (1M Depression) + .432 (Pain 3 groups) + .111 (PTA total)	*Y* = -.886 + .051 (RPQ) + .014 (Age) + .533 (Employment)	*Y* = -1.209 + .215 (1M Psychomotor) + .243 (1M Depression) + .012 (Age) + .113 (PTA total) + .583 (Employment)	*Y* = .717 + .076 (RPQ) + .487 (Pain 3 groups)	*Y* = .430 + .518 (1M Psychomotor) + .143 (PTA total) + .124 (1M Anxiety)

Table 8.15

Predicting HADS Scores at 24-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	1. Pain* – 16% 2. RPQ* – 21% 3. NART (4 groups) – 23% p = .137 4. MVA/Assault vs.** – 24% 5. MVA vs.** – 28%	1. 1M Anxiety*** – 39% 2. Pain** – 43% 3. Fatigue (2 groups) – 44% p = .052 4. 1M Psychomotor* – 45% 5. QOLI* – 47%	1. RPQ – 17% p = .057 2. Pain (3 groups) – 22% p = .042 3. QOLI** – 25% 4. PTA total – 26% p = .094	1. 1M Psychomotor** – 34% 2. 1M Depression** – 39% 3. Pain (2 groups)* – 42%	1. Pain (3 groups)** – 20% 2. RPQ*** – 26% 3. NART (4 groups)* – 29%	1. 1M Psychomotor*** – 40% 2. Pain (3 groups)* – 44% 3. NART (4 groups) – 46% p = .056
All variables expected to predict	1. Pain* – 16% 2. RPQ* – 21% 3. NART (4 groups) – 23% p = .137 4. MVA/Assault vs.** – 24% 5. MVA vs.** – 28%	1. 1M Anxiety*** – 39% 2. Pain** – 43% 3. Fatigue (2 groups) – 44% p = .052 4. 1M Psychomotor* – 45% 5. QOLI* – 47%	1. RPQ – 17% p = .091 2. Pain (3 groups) – 22% p = .146 3. QOLI* – 25% 4. Employment – 27% p = .082 5. PTA total – 28% p = .134	1. 1M Psychomotor** – 34% 2. 1M Depression** – 39% 3. Pain (2 groups)* – 42%	1. Pain (3 groups) – 20% p = .063 2. RPQ** – 26% 3. NART (4 groups)** – 29% 4. QOLI* – 31%	1. 1M Psychomotor*** – 40% 2. Pain (3 groups)* – 44% 3. NART (4 groups) – 46% p = .056
Clinician Variables	1. Pain (3 groups)** – 15% 2. RPQ* – 20% 3. MVA/Assault vs. – 23% p = .074	1. 1M Anxiety*** – 39% 2. Pain (3 groups)* – 42% 3. MVA/Assault vs. – 43% p = .120	1. RPQ** – 17% 2. Pain (3 groups)* – 22% 3. Employment – 23% p = .116	1. 1M Psychomotor* – 34% 2. 1M Depression** – 39% 3. Pain (3 groups)* – 42%	1. Pain (3 groups)** – 20% 2. RPQ** – 26% 3. Employment – 28% p = .138	1. 1M Psychomotor*** – 40% 2. Pain (3 groups)** – 44% 3. MVA/Assault vs. – 45% p = .145

Note. Percentages indicate percentage of variance explained.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8.16

Regression Equations Predicting HADS Scores at 24-Months from Variables Measured at the 1-Month Follow-up

	Anxiety Factor		Depression Factor		Psychomotor Factor	
Predictors	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*	*Excluding HADS*	*Including HADS*
Variables most likely to predict	*Y* = 1.615 + .230 (Pain) + .046 (RPQ) + -.298 (NART 4 groups) + -1.305 (MVA/Assault vs.) + 1.256 (MVA vs.)	*Y* = .045 + .513 (1M Anxiety) + .200 (Pain) + -.675 (Fatigue 2 groups) + .244 (1M Psychomotor) + .244 (QOLI)	*Y* = .494 + .027 (RPQ) + .573 (Pain 3 groups) + -.249 (QOLI) + .137 (PTA total)	*Y* = -1.055 + .233 (1M Psychomotor) + .329 (1M Depression) + .913 (Pain 2 groups)	*Y* = 1.600 + .972 (Pain 3 groups) + .058 (RPQ) + -.392 (NART 4 groups)	*Y* = .934 + .520 (1M Psychomotor) + .726 (Pain 3 groups) + -.318 (NART 4 groups)
All variables expected to predict	*Y* = 1.615 + .230 (Pain) + .046 (RPQ) + -.298 (NART 4 groups) + -1.305 (MVA/Assault vs.) + 1.256 (MVA vs.)	*Y* = .045 + .513 (1M Anxiety) + .200 (Pain) + -.675 (Fatigue 2 groups) + .244 (1M Psychomotor) + .244 (QOLI)	*Y* = -.291 + .027 (RPQ) + .470 (Pain 3 group) + -.265 (QOLI) + .860 (Employment) + .139 (PTA total)	*Y* = -1.055 + .233 (1M Psychomotor) + .329 (1M Depression) + .913 (Pain 2 groups)	*Y* = 3.140 + .720 (Pain 3 groups) + .046 (RPQ) + -.531 (NART 4 groups) + -.266 (QOLI)	*Y* = .934 + .520 (1M Psychomotor) + .726 (Pain 3 groups) + -.318 (NART 4 groups)
Clinician Variables	*Y* = 1.157 + 1.104 (Pain 3 groups) + .043 (RPQ) + -.727 (MVA/Assault vs.)	*Y* = .582 + .565 (1M Anxiety) + .762 (Pain 3 groups) + -.536 (MVA/Assault vs.)	*Y* = -1.264 + .044 (RPQ) + .701 (Pain 3 groups) + .759 (Employment)	*Y* = -.708 + .212 (1M Psychomotor) + .333 (1M Depression) + .557 (Pain 3 groups)	*Y* = -.656 + 1.139 (Pain 3 groups) + .055 (RPQ) + .891 (Employment)	*Y* = .544 + .506 (1M Psychomotor) + .920 (Pain 3 groups) + -.492 (MVA/Assault vs.)

8.4 Study 4 - Discussion

Study 4 aimed to examine which combination of demographic (Chapter 2 – Section 2.1), clinical (Chapter 2 – Section 2.2), and psychological/physiological (Chapter 2 – Section 2.3) variables would best predict TBI participants' mood outcome post-injury. HADS Anxiety, Depression, and Psychomotor factor scores were predicted at 3 months, 6 months, 12 months, and 24 months post-TBI, from predictor variables measured at the initial and 1-month follow-ups.

8.4.1 Initial Follow-up Predictors

The research question, *multiple regression will be performed to identify which of the demographic, clinical and psychological/physiological variables (discussed in Chapter 2) measured at the initial follow-up will significantly predict the HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI*, was well supported by the results, with a range of initial predictor variables found to significantly predict HADS scores at the later follow-up assessments. Each of the regression models predicting from the initial follow-up was highly significant and tended to account for a substantial proportion of the variance in participants' HADS scores (10–56%). A greater percentage of variance was explained by including the HADS factors as predictor variables in the models, which highlights the importance of assessing TBI participants' mood soon after injury, using the HADS.

Clinical and psychological/physiological variables tended to feature in the regression models more frequently than demographic variables. The predictor variables most often featured in the final 12 models included RPQ, pain, and the initial HADS Anxiety factor, suggesting these variables play an important role in predicting mood following TBI. QOLI, NART FSIQ, age, and the initial HADS Psychomotor factor featured in approximately half of the models. Predictor variables featuring in a small number of models (1–3) included: relationship status, employment, gender, hospitalisation (days), PTA, 'MVA vs. other TBI

causes,' 'MVA/Assault vs. other TBI causes,' fatigue, and the initial HADS Depression factor. When the variables were categorized according to groups (2, 3, or 4 groups), they tended to perform more poorly than when the variables reflected a total value or score. Orthopaedic injury was the only variable not to feature as a predictor variable in any of the models.

The percentage of variance explained by the regression models was greatest when predicting participants' HADS scores at 3 months post-injury, which is not surprising given that other factors in a participant's life may not yet have had time to influence mood. The initial HADS Anxiety factor, QOLI, RPQ, and pain (3 groups) accounted for 54% of the variance in participants' anxiety scores at 3 months; the initial HADS depression factor, QOLI, the initial HADS Anxiety factor, age, NART FSIQ, and MVA vs. accounted for 56% of the variance in participants' depression scores at 3 months; and the initial HADS Psychomotor factor, the initial HADS anxiety factor, QOLI, age, RPQ, and NART FSIQ accounted for 50% of the variance in participants' psychomotor scores at 3 months. A large percentage of variance was also explained when predicting participants' HADS scores at 6 months. The initial HADS anxiety factor, QOLI (2 groups), and pain (3 groups) explained 45% of the variance in participants' anxiety scores at 6 months; the initial HADS Depression factor, QOLI, age (4 groups), NART FSIQ, and RPQ explained 42% of the variance in participants' depression scores at 6 months; and the initial HADS Psychomotor factor, QOLI, the initial HADS Anxiety factor, and age explained 40% of the variance in participants' psychomotor scores at 6 months.

When predicting participants' HADS scores at 12 months, the initial HADS anxiety factor, pain, PTA total, and RPQ accounted for 35% of the variance in participants' anxiety scores; the initial HADS Psychomotor factor, age, RPQ, and NART FSIQ accounted for 27% of the variance in participants' depression scores; and the initial HADS Psychomotor factor

accounted for 22% of the variance in participants' psychomotor scores. When predicting participants' HADS scores at 24 months, the initial HADS Anxiety factor and pain explained 35% of the variance in participants' anxiety scores; the initial HADS Anxiety factor, RPQ, and pain (3 groups) explained 20% of the variance in participants' depression scores; and the initial HADS Psychomotor factor, pain, and the initial HADS Anxiety factor explained 27% of the variance in participants' psychomotor scores.

The initial HADS Anxiety factor made the largest statistically significant unique contribution to regression models predicting participants' anxiety scores at 3 months, 6 months, 12 months, and 24 months. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution to regression models predicting participants' anxiety scores at 3 months, 6 months, 12 months, and 24 months.

Variables providing the largest statistically significant unique contributions to regression models predicting participants' depression scores included: QOLI predicting depression scores at 3 months; age (4 groups) predicting depression scores at 6 months; initial psychomotor predicting depression scores at 12 months; and the initial HADS anxiety factor predicting depression scores at 24 months. When the HADS factors were excluded as predictor variables, QOLI provided the largest significant contribution to the regression model predicting participants' depression scores at 3 months; age (4 groups) made the largest significant contribution to the regression model predicting participants' depression scores at 6 months; and RPQ made the largest significant contribution to the regression models predicting participants' depression scores at 12 and 24 months.

When predicting psychomotor scores, the largest statistically significant unique contributions were made by QOLI and the initial HADS Anxiety factor predicting psychomotor scores at 3 months, and the initial HADS Psychomotor factor predicting psychomotor scores at 6 months, 12 months and 24 months. When the HADS factors were

excluded as predictor variables, RPQ made the largest significant contribution for predicting psychomotor scores at 3 months, 6 months, and 12 months; and pain made the largest significant contribution for predicting psychomotor scores at 24 months.

These are important findings, indicating that initial post-concussion symptoms and initial pain rating (both obtained within 1 week of TBI) can help predict mood up to at least 2 years post-injury. It should be acknowledged that the demographic variables were less involved in the prediction models than other types of variables, with fewer demographic variables featuring in the models, and when featured, they tended to contribute a smaller amount of variance.

8.4.2 Initial Follow-up Clinician Predictors

Additional regression analyses were conducted to assess which combination of *clinician variables* (i.e., those variables readily/more easily available to the clinician) would provide the best regression equations for predicting HADS factor scores from the data collected at the initial follow-up. Each of the regression models featuring clinician predictor variables measured at the initial follow-up were highly significant and tended to account for a substantial proportion of the variance in participants' HADS scores (ranging from 13–51%). When predicting participants' HADS scores at 3 months from initial follow-up clinician variables, the initial HADS anxiety factor, RPQ, and pain (3 groups) accounted for 51% of the variance in participants' anxiety scores; the initial HADS Depression factor, the initial HADS Anxiety factor, age, relationship status, and RPQ accounted for 41% of the variance in participants' depression scores; and the initial HADS Psychomotor factor, the initial HADS Anxiety factor, pain (3 groups), RPQ, relationship status, and age accounted for 44% of the variance in participants' psychomotor scores. When predicting participants' HADS scores at 6 months from initial follow-up clinician variables, the initial HADS Anxiety factor, hospitalisation (days), pain (3 groups), RPQ, and age, explained 43% of the variance in

participants' anxiety scores; the initial HADS Depression factor, age, RPQ, the initial HADS Anxiety factor, relationship status, and 'MVA/Assault vs. other TBI causes' explained 32% of the variance in participants' depression scores; and the initial HADS Psychomotor factor, the initial HADS Anxiety factor, age, RPQ, and hospitalisation (days) explained 36% of the variance in participants' psychomotor scores.

When predicting participants' HADS scores at 12 months from initial follow-up clinician variables, the initial HADS anxiety factor, pain (3 groups), PTA total, and RPQ accounted for 34% of the variance in participants' anxiety scores; the initial HADS Psychomotor factor, age, RPQ, and employment accounted for 26% of the variance in participants' depression scores; and the initial HADS Psychomotor factor, RPQ, age, employment, gender, the initial HADS Anxiety factor, and pain (3 groups) explaining 30% of the variance in participants' psychomotor scores. When predicting participants' HADS scores at 24 months from initial follow-up clinician variables*,* the initial HADS Anxiety factor and pain (3 groups) explained 34% of the variance in participants' anxiety scores; the initial HADS Anxiety factor, the initial HADS Psychomotor factor, and pain (3 groups), explained 22% of the variance in participants' depression scores; and the initial HADS Psychomotor factor, pain (3 groups), and the initial HADS Anxiety factor, explained 27% of the variance in participants psychomotor scores.

The initial HADS Anxiety factor made the largest statistically significant unique contribution to regression models predicting participants' anxiety scores at 3 months, 6 months, 12 months, and 24 months, from initial follow-up clinician variables. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution to regression models predicting participants' anxiety scores at 3 months, 6 months, 12 months, and 24 months, from initial follow-up clinician variables.

Variables providing the largest statistically significant contributions to regression models predicting participants' depression scores included: the initial HADS Depression factor when predicting depression scores at 3 months and 6 months; the initial HADS Psychomotor factor when predicting depression scores at 12 months; and both the initial HADS Anxiety and Psychomotor factors when predicting depression scores at 24 months. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution to regression models predicting participants' depression scores at 3 months, 6 months, 12 months, and 24 months, from initial follow-up clinician variables.

Variables providing the largest statistically significant contributions to regression models predicting participants' psychomotor scores included: both the initial HADS Psychomotor and Anxiety factors when predicting psychomotor scores at 3 months; and the initial HADS Psychomotor factor when predicting participants' psychomotor scores at 6 months, 12 months, and 24 months. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution to regression models predicting participants' psychomotor scores at 3 months, 6 months, and 12 months; and both RPQ and pain (3 groups) provided the largest significant contributions to regression models predicting participants' psychomotor scores at 24 months.

Overall, these findings point to the value of easy to obtain data for clinicians when couple with a HADS questionnaire in offering prediction of HADS scores even 2 years after TBI.

8.4.3 One-month Follow-up Predictors

Whilst it is important to be able to predict mood outcome very soon after TBI, practical considerations such as the accessibility of very severely head injured patients (i.e., those with PTAs longer than 1 week) and being able to arrange outpatient appointments for those not admitted to hospital, suggest data obtained 1 month after TBI may be a more realistic goal for

many services. Therefore, a series of additional stepwise regression analyses were performed, predicting participants' HADS factor scores at later follow-up assessments, from information gathered at the 1-month follow-up.

The research question, *multiple regression will be performed to identify which of the demographic, clinical and psychological/physiological variables (discussed in Chapter 2) measured at the 1-month follow-up will significantly predict the HADS factor scores at 3 months, 6 months, 12 months, and 24 months post-TBI*, was well supported by the results, with a range of 1-month predictor variables found to predict HADS scores at the later follow-up assessments. The regression models predicting from the 1-month follow-up tended to account for a substantial proportion of the variance in participants' HADS scores (ranging from 20–64%). As with the initial follow-up predictors, a greater percentage of variance was explained when the HADS factors were included as predictor variables in the models.

The predictor variables most often featured in the final 12 models included RPQ, NART FSIQ, QOLI, pain, and the 1-month HADS Anxiety and Psychomotor factors, suggesting these variables play an important role in predicting mood post-TBI, from the 1-month time period. Age and the 1-month HADS Depression factor featured in approximately half of the models. Predictor variables featuring in a smaller number of models (2–4) included: relationship, employment, PTA total, fatigue, and 'MVA/Assault vs. other TBI causes.' The predictor variables featuring in only one of the 12 models included: gender, 'MVA vs. other TBI causes,' hospitalisation, orthopaedic injury, and TBI cause. It is interesting to note that orthopaedic injury was featured in a small number of models and this may be related to the likelihood a greater percentage of participants would have attended the 1-month assessment with orthopaedic damage, compared to the initial follow-up. Consistent with the initial prediction models, when the variables were categorized according to groups

(2, 3, or 4 groups), they tended to perform more poorly than when the variables reflected a total value or score.

The percentage of variance explained was greatest when predicting participants' HADS scores at 3 months post-injury. The 1-month HADS Anxiety factor, NART FSIQ, QOLI, and QOLI (4 groups) accounted for 64% of the variance in participants' anxiety scores at 3 months; the 1-month HADS Depression factor, NART FSIQ, age, and QOLI accounted for 58% of the variance in participants' depression scores at 3 months; and the 1-month HADS Psychomotor and Anxiety factors, NART FSIQ, relationship, age, and QOLI accounted for 62% of the variance in participants' psychomotor scores.

A large percentage of variance was also explained when predicting participants' HADS scores at 6 months. The 1-month HADS Anxiety and Psychomotor factors, and NART FSIQ explained 55% of the variance in participants' anxiety scores at 6 months; the 1-month HADS Depression and Psychomotor factors, age (4 groups), NART FSIQ, and RPQ explained 47% of the variance in participants' depression scores at 6 months; and the 1-month HADS Psychomotor factor, orthopaedic injury (2 groups), RPQ, and NART FSIQ explained 52% of the variance in participants' psychomotor scores. These are very useful findings being able to predict future mood status from a small number of predictors.

When predicting participants' HADS scores at 12 months from the 1-month follow-up, the 1-month HADS Anxiety and Depression factors, pain (2 groups), and PTA total accounted for 52% of the variance in participants' anxiety scores; the 1-month HADS Psychomotor and Depression factors, age, NART FSIQ, and PTA total accounted for 40% of the variance in participants' depression scores; and the 1-month HADS Psychomotor factor, NART FSQI, pain (2 groups), and PTA total accounted for 50% of the variance in participants' psychomotor scores.

When predicting participants' HADS scores at 24 months from the 1-month follow-up, the 1-month HADS Anxiety factor, pain, fatigue (2 groups), psychomotor, and QOLI explained 47% of the variance in participants' anxiety scores; the 1-month HADS Psychomotor and Depression factors, and pain (2 groups) explained 42% of the variance in participants' depression scores; and the 1-month HADS Psychomotor factor, pain (3 groups), and NART (4 groups) explained 46% of the variance in participants' psychomotor scores.

The 1-month HADS anxiety factor provided the largest statistically significant unique contribution to regression models predicting participants' anxiety scores at 3 months, 6 months, 12 months, and 24 months, from the 1-month follow-up. When the HADS factors were excluded as predictor variables, QOLI provided the largest significant contribution to regression models predicting participants' anxiety scores at 3 months; RPQ made the largest significant contribution to regression models predicting anxiety scores at 6 months and 12 months; and 'MVA/Assault vs. other TBI causes,' 'MVA vs. other TBI causes,' pain, and RPQ provided the largest significant contributions to regression models predicting anxiety scores at 24 months.

Variables providing the largest statistically significant contributions to regression models predicting participants' depression scores included: the 1-month HADS Depression factor predicting depression scores at 3 and 6 months; and both the 1-month HADS Depression and Psychomotor factors predicting depression scores at 12 and 24 months. When the HADS factors were excluded as predictor variables, NART FSIQ and QOLI provided the largest significant contributions to the regression model predicting participants' depression scores at 3 months; RPQ, QOLI, age (4 groups), NART FSIQ, and gender made the largest significant contributions to the regression model predicting depression scores at 6 months; age, RPQ, QOLI, and NART FSIQ provided the largest significant contribution to the

regression model predicting depression scores at 12 months; and QOLI made the largest unique contribution to the regression model predicting depression scores at 24 months.

The 1-month HADS Psychomotor factor provided the largest statistically significant unique contribution to regression models predicting participants' psychomotor scores at 3 months, 6 months, 12 months, and 24 months from the 1-month follow-up. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution in regression models predicting participants' psychomotor scores at 3 months, 6 months, and 12 months from the 1-month follow-up; and both RPQ and NART (4 groups) made the largest significant contributions in regression models predicting participants' psychomotor scores at 24 months from the 1-month follow-up.

These are important findings, indicating that a number of variables measured at 1 month post-TBI can help predict mood up to at least 2 years post-injury. Interestingly, the regression models predicting from the 1-month follow-up showed stronger findings, compared with the initial follow-up regression models. Consistent with the findings from the initial follow-up multiple regression analyses, the demographic variables were less involved in the prediction models than other types of variables.

8.4.4 One-month Follow-up Clinician Predictors

Additional regression analyses were conducted to assess which combination of clinician variables would provide the best regression equations for predicting HADS factor scores from the data collected at the 1-month follow-up. These clinician variables tended to account for a substantial proportion of the variance in participants' HADS scores (ranging from 20–59%). The percentage of variance explained was greater when predicting participants' HADS scores at 3 months post-injury from 1-month clinician variables.

The 1-month HADS Anxiety factor and relationship accounted for 59% of the variance in participants' anxiety scores at 3 months; the 1-month HADS Depression and Anxiety

factors, and relationship status accounted for 50% of the variance in participants' depression scores at 3 months; and the 1-month HADS Psychomotor and Anxiety factors, relationship status, and RPQ accounted for 59% of the variance in participants' psychomotor scores at 3 months. A large percentage of variance was also explained when predicting participants' HADS scores at 6 months from 1-month clinician variables. The 1-month HADS Anxiety and Psychomotor factors explained 54% of the variance in participants' anxiety scores; the 1-month HADS Depression and Psychomotor factors, age, relationship status, and gender explained 47% of the variance in participants' depression scores; and the 1-month HADS Psychomotor and Anxiety factors and RPQ explained 50% of the variance in participants' psychomotor scores.

When predicting participants' HADS scores at 12 months from 1-month clinician variables, the 1-month HADS Anxiety and Depression factors, pain (3 groups), and PTA total, explained 52% of the variance in participants' anxiety scores; the 1-month HADS Psychomotor and Depression factors, age, PTA total, and employment accounted for 40% of the variance in participants' depression scores; the 1-month HADS Psychomotor factor, PTA total, and anxiety accounted for 47% of the variance in participants' psychomotor scores. When predicting participants' HADS scores at 24 months from 1-month clinician variables, the 1-month HADS Anxiety factor, pain (3 groups), and 'MVA/Assault vs. other TBI causes' explaining 43% of the variance in participants' anxiety scores; the 1-month HADS Psychomotor and Depression factors, and pain (3 groups) explained 42% of the variance in participants' depression scores; and the 1-month HADS Psychomotor factor, pain (3 groups), and 'MVA/Assault vs. other TBI causes' explained 45% of the variance in participants' psychomotor scores.

The 1-month HADS Anxiety factor provided the largest statistically significant unique contribution to regression models predicting participants' anxiety scores at 3 months, 6

months, 12 months, and 24 months, from the 1-month follow-up. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution to regression models predicting participants' anxiety scores at 3 months, 6 months and 12 months, from the 1-month follow-up, while pain (3 groups) provided the largest contribution to regression models predicting participants' anxiety scores at 24 months from the 1-month follow-up.

The 1-month HADS Depression factor provided the largest statistically significant unique contribution to regression models predicting participants' depression scores at 3 months, 6 months, and 24 months from the 1-month follow-up, and the 1-month HADS Psychomotor factor provided the largest significant contribution to regression models predicting participants' depression scores at 12 months from the 1-month follow-up. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution to regression models predicting participants' anxiety scores at 3 months, 6 months, 12 months, and 24 months from the 1-month follow-up.

The 1-month HADS Psychomotor factor provided the largest statistically significant unique contribution to regression models predicting participants' psychomotor scores at 3 months, 6 months, 12 months, and 24 months from the 1-month follow-up. When the HADS factors were excluded as predictor variables, RPQ provided the largest significant contribution to regression models predicting participants' psychomotor scores at 3 months, 6 months, and 12 months from the 1-month follow-up, and both RPQ and pain (3 groups) made the largest significant contribution to regression models predicting participants' psychomotor scores at 24 months from the 1-month follow-up.

Consistent with the findings from the initial predictor regression models, a small number of relatively simple measures were shown to help predict mood status over the first 2 years post-TBI.

8.4.5 Limitations

The limitations discussed in Study 1 (Chapter 5 – Section 5.4.13) also apply to the present study and will be discussed in more detail in the next chapter of this thesis.

8.5 Summary of Findings From Study 4

Study 4 aimed to determine which combination of variables from the previous studies would provide the best prediction of TBI patients' emotional outcome, over 2 years post-injury. The findings indicated post-concussion symptoms, pain levels, SQOL, and estimated pre-morbid intelligence, as well HADS anxiety and psychomotor scores collected at the initial and 1-month follow-ups, were the most consistently featured predictors across the regression analyses, and tended to account for a substantial proportion of the variance in participants' HADS scores at the later follow-up assessments.

Each of the regression models predicting from the initial and 1-month follow-ups was highly significant and tended to account for a very large proportion of the variance in participants' HADS scores (initial follow-up: ranging from 10–56%; 1-month follow-up: ranging from 20–64%). The results also indicated that strong prediction can be established, when predicting to 12- and 24-month periods post-TBI.

A striking finding was that participants' scores on the HADS could be predicted with great accuracy (13–59% of the variance explained) using a combination of variables easily available to the clinician (such as post-concussion symptoms, pain, fatigue, age, gender, relationship status, PTA, level of hospitalisation and employment status), and cause of injury (whether a participant sustained TBI from MVA or an assault). These are particularly important findings, given that psychological problems (including mood) are relevant to TBI patients' general recovery, including SQOL (Thomas, 2008), return to work, and relationships/family functioning (Bennett & Raymond, 1997). These findings have important service implications, which will be discussed in the next chapter.

Chapter 9

Grand Discussion

The emotional outcome of TBI patients is an essential area of study due to the high prevalence of mood disturbances following TBI and the detrimental impact of these problems on the lives of patients (Rapoport et al., 2003). However, there is little published research following the emotional recovery of patients with TBI. Therefore, this thesis aimed to investigate in a series of four studies, the relationship between the HADS (a measure of anxiety, depression, and psychomotor symptoms; Skilbeck et al., 2011) and a number of variables (demographic, clinical, and psychological/physiological) over 2 years following TBI—in order to identify those patients at risk of mood disturbance.

This large-scale Tasmanian-based population study consisted of 1,044 TBI patients (with a broad range of severity) identified from the Neuro Trauma Register database. Participants completed the HADS and a number of scales and interview questions soon after TBI (< 15 days post-injury), and at 1-month, 3-month, 6-month, 12-month, and 24-month follow-up assessments. The data was analysed in a series of longitudinal analyses (repeated measures ANOVAS), cross-sectional analyses (between subjects *t*-tests and ANOVAS), and multiple regression analyses. Overall, the descriptive statistics were consistent with previous TBI epidemiology studies and the large sample sizes suggest the findings reflect the true scores of the patients within the TBI clinical group, strengthening the findings of the present research (Khan et al., 2003; O'Connor, 2003; Tate et al., 1998). As expected, the median and mean ages of the cross-sectional sample were relatively young (32 and 36 years of age respectively), with a larger percentage of males (65%) than females. Consistent with previous research, the majority of participants sustained a mild TBI and there were higher rates of transport-related accidents, assaults, and falls, compared with other causes of injury.

9.1 Mood Recovery

TBI participants as a whole tended to show statistically significant recovery on the HADS Anxiety, Depression, and Psychomotor factors, over the 2-year period investigated. To determine whether the HADS scores of the participants were at a level that may warrant clinical attention, the mean normative HADS scores provided by Dunbar (et al., 2001) were used as comparative data. While TBI participants' HADS anxiety and psychomotor scores were higher than the normative sample at only the earlier follow-ups, their HADS depression scores remained higher than the normative sample across the 2-year period. As the HADS is a validated screening instrument for anxiety, depression, and psychomotor symptoms after TBI (Skilbeck et al. 2011), these results suggest a number of TBI participants may have experienced symptoms at a level requiring clinical attention. This is not surprising, given studies have consistently found patients are at risk of developing depression and anxiety disorders following TBI (McCleary et al., 1998; Moore et al., 2006). However, the present research showed TBI participants' anxiety, depression, and psychomotor symptoms tended to persist to at least 1 year after TBI. The persisting higher levels of depression scores in the TBI sample compared to the normative sample are of particular concern.

9.2 Studies 1–3

9.2.1 Study 1 – relationship between demographic variables and mood.

Study 1 investigated the influence of demographic variables (gender, age, est. pre-morbid IQ, relationship status, employment, and SES) on the emotional outcome of TBI patients over 2 years post-injury. As expected, significantly higher HADS scores were shown by: females, patients with lower pre-morbid IQ, patients not in a significant relationship, and patients who were unemployed or had lower SES. An unexpected finding was for patients in the middle age group (41–59 years) to report significantly higher scores on the HADS than other age groups, suggesting middle age patients may be at risk of faring worse emotionally after TBI.

As discussed in Chapter 2 (Section 2.1.2), few studies have examined age differences in mood post-TBI. The present finding differs from the small number of studies that suggests older patients experience poorer mood outcome (Glenn et al., 2001; Rapoport, 2003), but is consistent with a recent dissertation by Gabel (2012) which found middle age TBI participants showed increased levels of depression, compared with other age groups. The middle age group may face an increased vulnerability to mood disturbance after a head injury, because of existing major life stressors (e.g., children leaving home, death of a parent, career changes; Levinson, 1978).

Of the six demographic variables investigated, gender was the only variable which displayed consistently small effect sizes across each of the post-trauma follow-ups, indicating a weak relationship between HADS scores and gender in the present research. Although many of the effect sizes were small in the analyses of age, est. pre-morbid IQ, relationship status, employment, and SES, considerable effect sizes were found for differences in HADS scores based upon these variables at particular follow-up assessments. This suggests that certain groups of TBI patients are more vulnerable to heightened symptoms of mood disturbance at specific times over the first 2 years after their injury.

In particular, at 1 month post-TBI, there were moderate effect sizes for: participants' in the middle age group to report the highest anxiety and depression scores of the four age groups, participants in the below average IQ group to report the highest anxiety scores of the pre-morbid IQ groups, and unemployed participants to report higher depression scores than employed participants. At 3 months, there were moderate effect sizes for unemployed participants to report higher depression scores than employed participants, and for participants with lower SES to report the highest anxiety scores of the SES groups. At 6 months, there was a moderate effect size for unemployed participants to report higher anxiety

scores than employed participants, and there was a large effect size for unemployed TBI participants to report higher depression scores than employed TBI participants at 24 months.

The results from the multiple regression analyses performed in Study 1 indicated some of the demographic variables provided statistically significant unique contributions to the regression models, predicting participants HADS scores over 2 years post-TBI. A proportion of the variance (ranging from 7–17%) was explained from participants' est. pre-morbid IQ, age and gender, measured at the initial and 1-month follow-ups.

9.2.2 Study 2 – relationship between clinical variables and mood. Study 2 examined the influence of clinical variables (hospitalisation, TBI severity, orthopaedic injury, and cause of injury) on the emotional outcome of TBI patients over a 2-year post-injury period. As expected, higher scores on the HADS were shown by: patients with more severe TBI, patients with greater number/severity of orthopaedic injuries, and patients who had sustained TBI from assault, car, and motorcycle accidents. A surprising finding was for TBI patients not admitted to hospital to show heightened symptoms of anxiety soon after their injury compared to hospitalised TBI patients, with severity of anxiety symptoms then dissipating over time. As discussed in Chapter 6 (Section 6.4.3), TBI patients who are not admitted to hospital may be provided with little information as to possible post-concussion symptoms they may experience, and subsequently develop anxiety if these symptoms arise soon after TBI.

Of the clinical variables investigated, hospitalisation was the only variable which displayed consistently small effect sizes across each of the post trauma follow-ups, suggesting a weak relationship between HADS scores and hospitalisation in the present research (Pallant, 2009). Although many of the effect sizes were small in the analyses of severity, orthopaedic injury, and cause of injury, considerable effect sizes were found for differences in HADS scores based upon these variables at particular follow-up assessments in

the early period after TBI (over the first 3 months). At the initial follow-up, there was a medium effect size for participants without orthopaedic injury to report higher anxiety scores than participants with orthopaedic injury. As discussed in Chapter 6 (Section 6.4.6) this finding may be related to distraction/preoccupation with physical concerns at this early time period. A moderate effect size was found at 1 month, for participants with moderate/severe TBI to display higher depression scores than mild TBI participants. There were moderate effect sizes at the initial, 1-month, and 3-month follow-ups for participants injured in car accidents to report the highest anxiety scores of the transport-related cause of injury groups. This finding may relate to issues unique to this type of transport-related injury, such as managing car damage, motor vehicle insurance, and possible accident-related court cases (See Chapter 6 – Section 6.4.8).

The results from the multiple regression analyses performed in Study 2 indicated some of the clinical variables provided statistically significant unique contributions to the regression models predicting participants' HADS scores over 2 years post-TBI. A small proportion of the variance (ranging from 1–9%) was explained from participants' TBI severity, level of hospitalisation, and cause of injury ('MVA/assault vs. other cause of injury'), measured at the initial and 1-month follow-ups.

9.2.3 Study 3 – relationship between psychological/physiological variables and mood. Study 3 examined the influence of the psychological/physiological consequences of head injury (pain, fatigue, quality of life, and post-concussion symptoms) on the emotional outcome of TBI patients over a 2-year post-injury period. Of all the variables investigated in the present research, the psychological/physiological variables demonstrated the strongest relationships with the HADS factors. Participants consistently showed significant differences in their emotional outcome based upon the psychological/physiological variables examined—with large effect sizes generally found across the 2-year period. As expected, higher scores on

the HADS were shown by patients with greater levels of pain and fatigue, lower levels of SQOL, and increased severity of post-concussion symptoms.

A striking finding was for pre-injury measures of pain, fatigue, and SQOL to show strong relationships with participants' HADS scores measured post-injury. Substantial effect sizes were found for participants with greater pain levels measured at the initial follow up to report higher HADS scores at each follow-up compared with participants in other pain groups, and for participants with greater initial fatigue levels to report higher psychomotor scores at the initial, 1-month, and 3-month follow-ups, compared with other fatigue groups. There were substantial effect sizes found for participants with low pre-injury SQOL to display higher depression and psychomotor scores at 3 months and 6 months, and higher anxiety scores at 6 months, when compared with participants with low pre-injury SQOL.

The results from the multiple regression analyses performed in Study 3 indicated a number of variables provided large statistically significant unique contributions to the regression models predicting participants' HADS scores across the 2-year period. A considerable proportion of the variance (ranging from 19–53%) was explained from participants' level of pain, SQOL, post-concussion symptoms, and HADS Anxiety, Depression, and Psychomotor factor scores, measured at the initial and 1-month follow-ups.

9.2.4 Clinical implications. The findings from Studies 1–3 point to a complex relationship between mood following TBI and the demographic, clinical, and psychological/physiological variables measured. Some of the variables showed persistently strong relationships with participants' mood across the 2-year period, including the psychological/physiological variables: pain, fatigue, SQOL, and post-concussion symptoms. However, a number of demographic and clinical variables showed strong relationships with participants' mood only at particular follow-ups (age, est. pre-morbid IQ, employment, SES, TBI severity, orthopaedic injury, and transport-related cause of injury). Nevertheless, the

findings from the present research suggest that particular groups of patients are at risk of mood disturbance post-TBI. Those most at risk across the 2-year period are patients with greater pain and fatigue levels, greater levels of post-concussion symptoms, and lower SQOL. The research suggests that other groups may be at risk during the 2-year period including patients who are: middle aged (41–59 yrs), have lower est. pre-morbid IQ, unemployed, have lower SES, greater severity of injury, have TBI caused by car accidents (compared to other transport-related TBI), and those without orthopaedic injury.

One-month appears to be a point at which TBI participants are particularly vulnerable to increased mood disturbance. Participants' HADS scores tended to spike at this early time period and larger effect sizes were found for differences amongst groups at this time point. These results highlight the need for screening TBI patients' emotional recovery soon after their injury, to allow for early identification of patients in need of intervention. To accelerate recovery and prevent a psychological snowball effect, early identification and treatment of emotional symptoms is crucial (Bennett & Raymond, 1997). From as early as possible after brain injury, it is important that patients receive emotional support and education on both the effects of brain injury and techniques to assist in coping with altered post-injury functioning, with a range of treatment options available (Bennett & Raymond, 1997).

Early screening is particularly important given the high incidence of TBI patients in the mild category of severity (Khan et al., 2003). Many of these individuals do not present to hospital, or if they attend hospital, are likely to be discharged after attending the emergency room without any assessment of their emotional state (Khan et al., 2003). Screening for mood disturbance can take little time and may be routinely performed when a patient visits a G.P. shortly after sustaining a mild brain injury, upon admission to hospital, or as an outpatient (by Allied Health Professionals e.g., Rehabilitation Physicians and Clinical Neuropsychologists). Given the cost and burden of mental illness on society and individuals (Silver, et al., 2005),

the increased prevalence of mood disturbance after TBI (Rapoport et al., 2003) and the findings from the present series of studies, it is strongly recommended that patients be routinely screened for mood disturbances after sustaining a TBI. Due to the persistence of mood problems across the 2-year period in the present research (particularly depression symptoms), it is also recommended that where possible, clinicians continue to monitor patients' emotional recovery over the initial 2-year period following TBI, in order to identify those patients most at risk of mood disturbance—with appropriate referrals made.

The HADS in particular has been found to provide a valid measure of anxiety, depression, and psychomotor symptoms in TBI patients (Skilbeck et al., 2011), whilst refraining from focusing on the more sensitive psychiatric areas that other questionnaires measure. The present research strongly supports the use of the HADS within the TBI clinical group, particularly employing the Skilbeck et al. (2011) HADS three factor structure. While considerable sized correlations were found between each of the HADS factors, patients showed differing patterns of recovery on each of the factors. Each HADS factor demonstrated an important role in prediction, both as independent and dependant variables.

9.3 Study 4 – Predicting HADS Scores Following TBI

As little research has explored the prediction of emotional outcome following TBI, Study 4 aimed to determine which combination of variables would provide the best prediction of TBI patients' emotional outcome, over the 2-year post-injury period. A multiple regression design was employed to examine whether demographic, clinical, and psychological/physiological variables at the initial and 1-month follow-up assessments could be used to predict participants' HADS scores at later assessments—3 months, 6 months, 12 months, and 24 months post-injury. In order to eliminate erroneous variables, variables were entered into the models based on their performance in the exploratory regression analyses of Studies 1, 2, and 3.

The multiple regression analyses in Study 4 revealed some important findings. As expected, a number of variables were found to significantly predict participants' HADS scores. These variables accounted for an impressive proportion of the variance in participants' HADS scores (initial follow-up predictors: ranging from 10–56%; 1-month predictors: ranging from 20%–64%). Strong prediction was established not just at the earlier follow-up assessments (3 months and 6 months), but also when predicting the later follow-ups, with regression models explaining up to 52% of the variance in participants' HADS scores at 12 and 24 months.

The strongest and most consistently featured predictors in the final regression models were the psychological/physiological variables (post-concussion symptoms, pain levels, pre-injury and initial SQOL, HADS anxiety and psychomotor scores) and the demographic variable est. pre-morbid IQ, collected at the initial and 1-month follow-ups. Other demographic variables (age, gender, relationship status, and employment status) and the psychological/physiological variable fatigue were featured in the regression models when predicting HADS scores at specific time points. Interestingly, although some of the clinical variables (TBI severity, level of hospitalisation, and cause of injury) were featured in the regression models performed in Study 2, these variables rarely featured in the models and accounted for very little of the variance when demographic and psychological/physiological variables were also entered into the regression analyses, indicating clinical variables played a smaller role in predicting mood outcome.

9.3.1 Clinical implications. As shown above, the multiple regression analyses in Study 4 provide valuable information as to which patients are more likely to develop mood disturbance following their injury. Additionally, the results indicated participants' scores on the HADS could be predicted with great accuracy (13–59% of the variance explained) using a combination of measures easily available to the clinician. These included, the Westmead PTA

scale (a measure of TBI severity; Shores et al., 1986), the RPQ (a measure of post-concussion symptoms; King et al., 1995), the Visual Analogue Scale for Pain and Fatigue (VAS-P; VAS-F; Hayes & Patterson, 1921), and the HADS (Zigmond & Snaith, 1983. The advantages of these particular measures are they take little time to administer and score (e.g., the HADS usually takes between 2 to 5 minutes to complete), and are commonly used with TBI patients in the hospital environment. A number of other variables were included in the regression models that can easily be measured when a clinician collects a patient's history, including the patient's age, gender, relationship status, level of hospitalisation (hospitalised/not-hospitalised), employment status (unemployed/employed), and cause of injury (whether a participant sustained TBI from MVA or an assault).

The regression equations provided in Chapter 8 can be used by clinicians to predict a patient's HADS factor score at a particular time period post-injury. In its original form (Snaith & Zigmond, 1994), the HADS contains two subscales, an anxiety scale and a depression scale. However, to use the regression equations provided in the present research, HADS factor scores according to the Skilbeck (et al. 2011) model can be computed using the method described in Chapter 5 – Section 5.2.5. Additionally, if a clinician has access to other more comprehensive information (such as a patient's NART-R FSIQ or QOLI score), they can use the regression equations provided in Chapter 8 to predict a patient's HADS score at a particular time period post-injury. The NART-R and QOLI are both tools that take little time to administer and are suitable for use in TBI populations (Thomas, 2008).

9.4 Strengths of The Present Research

The present research had a number of strengths. Firstly, this was a population study with a very large total sample size of TBI patients across a broad spectrum of severity. Many TBI studies have smaller sample sizes and focus on a particular type of severity, such as mild patients. The large sample size made it possible to provide a comprehensive exploration of

the variables by categorising variables in a number of different ways and by performing analyses on both cross-sectional and longitudinal data.

TBI studies tend to examine outcome at one specific time-point within the first year post-injury (Moore, 2006), or lack specificity by pooling the data of participants who were assessed at various stages following TBI (Glenn et al., 2001). The present research had the advantage of following patients' mood recovery at six follow-up assessments over a 2-year period, with patients only included in the analyses if they attended follow-ups assessments with defined time periods. As mentioned earlier, participants' HADS scores behaved differently depending on the follow-up assessment analysed. This suggests it is important to take into consideration the time period at which a patient is assessed for mood disturbance rather than simply whether or not they have sustained a brain injury. The findings also indicated some of the groups in the analyses showed significant differences in levels of psychomotor symptoms with considerable effect sizes over 2-years post-trauma. This suggests that TBI patients are not only vulnerable to symptoms of anxiety and depression, but also psychomotor symptoms, which can affect a patient's wellbeing post-TBI (Silver et al., 2005). This provides an important contribution to the literature as few studies have examined the psychomotor domain post-TBI.

The author was fortunate to have access to a very large database relating to orthopaedic injuries sustained by the participants. Given no published research appears to have examined the relationship between orthopaedic injury and the emotional recovery of TBI patients and there are no known methods of categorising orthopaedic data, the analyses of orthopaedic injury performed in the present research may provide a guide for future studies. This research found orthopaedic injury could be categorised in a number of ways including: presence of orthopaedic injury, number of orthopaedic injuries, and severity of orthopaedic injury (see Chapter 6 – Section 6.3.4). The findings of the present research tended to show small

relationships between orthopaedic injury and the HADS. However, at the initial follow-up, there was a medium effect size for participants without orthopaedic injury to report higher anxiety scores than participants with orthopaedic injury. One explanation may be that patients with orthopaedic injuries are more distracted/preoccupied by physical concerns at this early time period.

9.5 Limitations and Future Research

The present research was not without limitations. The small effect sizes should be acknowledged and may indicate some of the findings were statistically significant simply due to large sample sizes (Pallant, 2009). Greater weight should be placed upon the results where larger effect sizes were found, as these findings indicate meaningful differences in levels of mood disturbance of the groups (Pallant, 2009). Some different patterns of recovery on the HADS were found between the longitudinal and cross-sectional sample analyses. This may be accounted for by the different characteristics of these samples (Langley et al., 2010). For example, participants who attended all follow-ups tended to have slightly higher mean and median ages and a reduced length of PTA, when compared to participants who did not attend each follow-up. It should also be acknowledged that many of the participants voluntarily withdrew from the present research once they had returned to pre-injury functioning, as they "did not see the need to continue."

It is difficult to determine at what point a participant's HADS score is in the 'clinical' range using the Skilbeck (et al., 2011) factor scores, given the original scoring system for the HADS raw scores (Zigmond & Snaith, 1983) cannot be used for interpreting transformed factor scores. Although the findings indicate some large differences between the present study and the normative sample in terms of the mean HADS scores reported, these findings should be interpreted with caution due to differences in the age ranges of the samples and the lack of statistical analyses performed comparing Dunbar et al. (2000) data with the present

data. The Dunbar et al. (2000) normative sample reported findings from three very narrow age ranges (18–19 years; 39–40 years; 58–59 years), whereas the present study utilised a much broader age range (16–91 years). Future research that uses the HADS three-factor structure (Skilbeck et al., 2011) with clinical populations would benefit from access to normative data that includes a more representative sample of the normal population.

The present research found TBI patients involved in car accidents experienced the highest levels of anxiety scores of all the transport-related cause of injury groups. There are many factors that may relate to this (e.g., accident circumstances and severity of the accident) which future research could explore. The relationship between cognitive functioning and mood was outside of the scope of the present research, but could also be considered in future.

The present research used crude measures to categorise orthopaedic injury, given the lack of previous research in this area. In order to facilitate future research, a validated classification system of orthopaedic injury would be beneficial. As physical injuries associated with TBI can lead to increased levels of pain and pain has been found to relate strongly to mood outcome post-TBI, when developing a classification system of orthopaedic injury, the severity of the orthopaedic damage should be considered.

Overall, the findings from the present research point to particular groups of patients that are at risk of mood disturbance post-TBI and who will require greater support/therapy. The findings highlight the utility of collecting information relating to a patient's demographic, clinical, and psychological/physiological history and the importance of screening for mood problems post-TBI using questionnaires such as the HADS. However, given the exploratory nature of the present research, a replication of findings would be beneficial.

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